METAL INDUSTRY

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Accident Prevention

IN 1957, the total number of reported accidents in all premises subject to the Factories Acts was 174,713, of which 651 were fatal. The corresponding figure for the previous year was 184,785, of which 687 were fatal, and this represents a decrease of over 5 per cent in all reported accidents. These facts emerge from the recently issued report for 1957 of the Chief Inspector of Factories. The number of non-fatal accidents has continued the downward trend which was shown in the 1956 report, while fatal accidents have decreased every year since 1951. The figures for all accidents are the lowest reported since 1935, when the volume of industrial activity was very much less than it is at present. The report points out that it is difficult to draw valid conclusions when comparing accident statistics for different years, because of changes in population at risk to accidents, changes in the pattern of hours worked, and other factors. Nevertheless, the total employment figures for 1957 show little change from those of 1956, and it is reasonable to suppose that the continued improvement in accident figures has resulted, apart from these other factors, through safer working methods and better and safer machinery and equipment.

One interesting and, perhaps, obvious fact, which emerges from the analysis of accidents by industries, is the variation in severity of accidents from industry to industry. While there is no satisfactory method of estimating the severity of accidents, it is possible as a rough indication to compare the proportion of fatal accidents with the total number of accidents in different industries. For example, one in every 270 of all reported accidents was fatal; but at building operations and in *metal extracting and refining processes*, one in 90 was fatal; in textile factories, on the other hand, only one in every 930 reported accidents was fatal. An analysis of the nature and site of injuries associated with various accident classifications is given in Table 5 of the report. Seventy-nine per cent of the total of machinery injuries occurred to the hands and arms. Injuries due to *molten metal and other hot and corrosive substances* were widely distributed over the parts of the body, and the use of protective footwear and of eye protection might well have prevented many of these injuries.

Dealing with the subject of safety training, the Report says that it is not possible to say with any precision how great a part lack of adequate safety training plays in the causation of accidents, but it is certainly considerable. It may well be that developments in this sphere now offer the main prospect for further advance in reducing the toll of accidents in industry. Brief, enthusiastic campaigns against accidents have their uses, but it is only through the systematic training and the stimulation of co-operation between workers and management that new habits of safety can be performed among workers and safety consciousness encouraged.

Reference is made in the report to the four main fields through which safety training has recently been developed. They are technical colleges and schools, safety training in industry itself as an integral part of the instruction which every worker should receive when he goes to a new job in industry, the Birmingham Industrial Safety Training Centre, and Job Safety Courses through the Training Within Industry Scheme. The report also emphasizes the importance of the contribution which workers can make in solving safety problems. Instances occur each year where a suggestion from the shop floor leads to development work with the encouragement, and sometimes the assistance, of the Inspectorate.

Out of the
MELTING POT

Now Acceptable

NOT so long ago, powder metallurgy was indeed concerned with the processing of *metal* powders by methods of powder metallurgy. In the course of its operations, much care was taken to ensure that metal powders did, in fact, remain metal, and only metal, powders. Protective or reducing atmospheres were provided to prevent oxidation during sintering, and to reduce any oxide present in the starting material. Where any non-metallic material was added to the powder to begin with, e.g. to act as a lubricant during pressing or to control porosity, arrangements were made for its complete removal by volatilization or decomposition during the initial stages of the subsequent sintering process. While some powder metallurgical products (bearings containing graphite, friction materials) incorporating non-metallic constituents were made, one always felt that their inclusion into the fold was either an act of courtesy or a means of enhancing the impression of the versatility of powder metallurgy. This inclination towards metals to the exclusion of everything else had to be abandoned to include the much more extensive investigations and admittedly limited and laboured achievements in the cermet field. As with materials so with techniques, the receptiveness of powder metallurgy has undergone a marked growth, the extent of which can be appreciated by noting, for example, the interest shown in such an entirely "alien" process as slip casting, any suggestion of which would, not so very long ago, have been scornfully rejected on the grounds that a method which did not apply so many tons/in^2 pressure to the powder could not possibly be any use and that, moreover, it introduced the risk of contamination of the metal powders by reaction with the liquid suspending medium. Where formerly hands would have been thrown up in horror, one feels that with the present attitude an interest will be taken even in one of the latest suggestions:—the use as a binding agent of finely divided alumina of low bulk density and a solution in water of colloidal alumina (alumina gel). This binder is mixed with the metal, metal carbide, boride or other powder in such a proportion as to produce a mass of a consistency suitable for extrusion or other method of shaping. The shaped and dried articles are strong enough to be handled prior to sintering.

Permanent Misfits?

THE fact that there have always been unrecognized geniuses, or, at any rate, geniuses for whom life had not been as easy as it might have been, should not be used as an excuse that nothing need be done about it. There is by now sufficient evidence that the work of geniuses invariably proves valuable in the long (however long) run. Geniuses being few and far between, the methods of recruiting scientific and technical staff cannot really be expected to be designed to cope with them. To begin with, judging from the advertisements under "Situations Vacant," there is absolutely no demand at all for geniuses. The questions in a typical application form are not such as to reveal that the applicant is, in fact, a genius, and how many personnel managers can claim that they have not missed the rare opportunity of engaging a genius as a result of failing to recognize peculiarities of his letter of application for what they really were—marks of genius. One could go on in the same strain to consider the chances, or rather lack of them, of a genius successfully passing a personal interview, assuming he had actually been asked to attend for one. Finally, it is only too easy to visualize the difficulties that would arise from the presence of a genius in the average research or design team, and the repercussions they would have on the genius. On a more serious and less hypothetical level, some thought should certainly be given to the above problems. In the most general terms, they point to the need of providing jobs for some extraordinary people, in addition to the more usual need of finding people for the more ordinary jobs. In these days of efficiency, organization, management, productivity and the rest, it seems wrong that the potential utility of the efforts of somebody—even if only a genius—should be wasted.

To the Uncommon

SOMEBODY with more space and time than are available to me might sometime soon perform the useful service of surveying the various types of cores nowadays available to the founder. Having surveyed the main portion of the field, the survey would need to provide a concluding section dealing with the more unusual types of cores that have been found to provide answers in those cases in which otherwise the parts "could not even be cast." It would include, for example, the tubular metal cores which can be formed into the most fantastic convolutions to form corresponding passages in the casting, and which are dissolved out of the finished casting by a reagent that will attack them but not the material of the casting. It would also include a development of the above tubular metal cores, in which the metal core is surrounded by a fully flexible gas-permeable refractory sleeve, which is supported against collapse by the metal tube. The refractory sleeve may consist of woven glass fibres, asbestos, or intertwined stainless steel strands. After the casting has been poured and allowed to solidify, the supporting metal tube is dissolved in a suitable reagent, and the refractory sleeve is then withdrawn from the casting. Finally, the review would certainly have to include some reference to the cores that are now being used in the most unusual circumstances and for a most unusual purpose, namely, in the continuous casting of billets which are subsequently rolled down into "tube-in-strip" material, in the course of which rolling the cores are crushed and then serve to maintain discontinuities in the strip which later can be expanded by fluid pressure into tubular configurations. Cores for this application must not only be able to act as cores, but they must also be crushable to a fine stop-weld powder which, additionally, must be such that traces of it retained in the tube bores will not cause corrosion in the presence of a liquid, e.g. in heat exchangers. Such cores have been made of graphite, soapstone and magnesia, and also of glass, aluminium silicate, or fused quartz fibres woven braided or felted into tapes or sheets or tubes, which may be reinforced by flexible paper or board strips, etc., the latter containing suitable loading materials such as Bentonite, talc, etc.

Skimmer

APPLICATIONS IN ROLLING, DRAWING AND EXTRUSION

Glass Lubricants in Metallurgy

Glass lubrication is being increasingly used in metal working, particularly in hot pressing, stamping, boring and in the hot shaping of high alloy steels, molybdenum, vanadium, zirconium and titanium. This article, which has been specially translated from the Russian of L. K. Kovalev and V. A. Ryabov in Steklo i. Keramika, by Kenneth Shaw reviews some of the applications of glass lubrication and the techniques involved in the processes.

IN many countries, especially in France, workers have studied the hot pressing of profile tools and tubes from different steels and non-ferrous metals. However, the adoption of this new technique has been delayed because of the rapid wear of the press fittings and instruments: containers (boxes), draw plates (dies), punches, and the riveting drift, which become unfit sometimes after only the first pressing.

It has been proved that satisfactory results can be obtained only by using a lubricating medium which, when working at pressing temperatures of 900°-1,350°C., possesses high heat insulation and anti-friction properties and is converted into an adequately viscous state. As a result of more than ten years' experimental and factory work, the French research workers, I. Peishes and J. Séjournet, have shown that such a lubricant can be obtained with silicate glass.

At present, glass is already being used in drawing steel. The use of a glass lubricant has opened up the possibility of developing a technique for hot boring in which it is necessary to attain special accuracy in forming the surface. In open-hearth production during the casting of the steel ingots, glass is introduced into the moulds and creates a heat barrier between the molten metal and walls of the moulds. Glass eliminates splashing of the metal, and, not entering into any reaction with the metal, it comes to the surface in the form of small quantities of slag.

A great future is envisaged for the use of glass in the rolling of metals, as a lubricant in bushings, motors, etc. The possibility is being considered of using glass for lubricating metals for "air" bushings of low friction at temperatures higher than 540°C.

The uniform layer of glass lubricant permits the manufacture of metal tubes with a regular structure and uniform physico-mechanical properties along the whole length, not obtainable with other types of lubricant. This considerably increases the output and efficiency of the die, box and plunger.

According to data from L. V. Prozorov, the coefficient of friction during hot pressing of steel for lubrication by graphite mixed with petrolatum equals 0·026 to 0·03, for a lubricant of graphite mixed with glass it is 0·026 to 0·035, and for glass lubricant alone it is 0·027 to 0·033.

Glass lubricants have special value in the manufacture of tubes by extrusion from alloy steel of the ferrite class when carbon lubricants are unsuitable owing to carbonizing of the metal during the production process.

The successful use of glass as a lubricant in the pressing of steel has led to the broad application of it for other purposes in industrial shaping of different metals in the hot state: the pressing of silicon and aluminium bronzes, light alloys, high speed, heat-resistant and corrosion-resistant steels and titanium alloys.

During pressing with glass lubricants, the specific pressure on modern presses reaches a considerable magnitude, and varies from 40 to 120 kg/mm² at a temperature of 800°-1,300°C.

The layer of glass lubricant between the die and the preheated blank under pressure begins to flow, covering the formed article with a glass coat.

The thickness of the glass film on the shaped metal may reach 20-100μ. With existing speeds of hot pressing, the whole of the process continues for 2-6 sec., depending on the length of the rod. To ensure the normal stroke of pressing, it is essential that the glass lubricant with the given physico-mechanical and thermal properties moves regularly and uniformly, and covers the article on all its surfaces with an unbroken, thin layer.

J. Séjournet considered that the main properties influencing the effectiveness of the glass lubricant are its thermal conductivity and its viscosity. Temperature conductivity, or, as Séjournet termed it, heat diffusion, characterizes the speed of change of temperature of the body during its transfer to a medium possessing another temperature.

$$K = \frac{\lambda}{c\gamma}$$

where λ=thermal conductivity
c=specific heat
γ=bulk density of the glass.

The change in specific heat, according to proposals by O. K. Botvinkin, may be calculated from the following equations:—

$$C_{0-550^\circ} = 0{\cdot}1794 + 0{\cdot}632 \times 10^{-4}\, t^\circ;$$
$$C_{750-1,200^\circ} = 0{\cdot}1605 + 1{\cdot}1 \times 10^{-4}\, t^\circ.$$

In practice, the value of specific heat of glasses lies in the range 0·28-0·08 cal/gm/°C. The value of the thermal conductivity varies from 0·001 to 0·0032 cal/cm/sec/°C. The specific weight of glass equals 2·2-6.

The numerical value of viscosity for the three-component system SiO_2-CaO-Na_2O from 900° to 1,500°C. may be obtained from the viscosity diagrams of Washbourne, Shelton, and Libman. The value of the viscosity for sodium-calcium-alumino-magnesia glasses can be determined from the formula of M. V. Okhotin.

$T = ax + by + cz + d$ where T = temperature corresponding to the viscosity of 10^3, 10^4 and 10^5 poises, and a, b, c, d are table constants. The content of $Na_2O - x$ per cent; the total $CaO + MgO - y$ per cent, and the Al_2O_3 content $- z$ per cent.

Experiments carried out by the authors at the Institute of Glass showed that an important role with glass lubrication is played by other physico-mechanical properties of the glass, e.g. degree of wetting of the metal by the glass, the critical nature of the glass film on the shaped article, corrosion of the metal by the glass, etc. Thus, if two rods of heat-resisting alloy—one made from nickel and chromium and the other with a considerable quantity of molybdenum and tungsten in it—are immersed for 15 min. in molten glass of the same composition at 1,300°C., then the first rod will be completely covered with glass but the second will be completely free from it.

As reported by Peishes, the thickness of the film, determined by using radioactive strontium with the aid of a Geiger counter, can be as much as 20 microns. Titanium alloys usually develop a tendency for thorough wetting by the molten glass at 1,050°-1,100°C. This is especially observed with glasses containing beryllium, boric and lithium oxides. The relationships of molten glass to the metal of the die, containers and blank may be very different.

TABLE I—GLASS COMPOSITIONS

Mark of Lubricant	Content (per cent)				
	SiO_2	B_2O_3	$Al_2O_3 + TiO_2 + Fe_2O_3$	CaO	Na_2O
P—478	52·68	8·91	5·98	5·52	26·54
P—479	51·26	8·12	6·55	3·06	31·72
P—480	54·8	7·68	9·39	8·63	23·15

TABLE II—GLASSES FOR STEEL PRESSINGS

	Contents (per cent)							Viscosity in Poises				
No.	SiO_2	Al_2O_3	CaO	Na_2O	K_2O	B_2O_3	Other Oxides	800°C	900°C	1,000°C	1,100°C	1,200°C
1	56	15	18	2	—	7	2	—	—	51,200	5,800	1,400
2	65	3	10	15	—	—	7	—	—	11,200	3,100	620
3	50	—	15	19	5	3	8	18,130	9,010	1,610	345	45
4	56	2	15	20	3	2	2	2,458	13,560	1,890	520	160
5	60	3	15	15	—	3	4	—	21,200	4,150	840	260

Of no less importance are the coefficients of heat expansion of blank and die, and also the character of the oxide film formed between the metal and glass. The greater the difference between the coefficients of heat expansion, then the easier will be the freeing of the finished article from the glass lubricant covering it.

The volume coefficients of heat expansion of glasses suitable for lubricants are located in the range from $17{\cdot}5\times10^{-7}$ to 300×10^{-7} and rising with temperature increase. The most important factor appears to be the length of time over which the glass keeps its working or forming viscosity, i.e. the speed of hardening of the glass lubricant, which is determined principally by the temperature and composition of the glass. The longer the working viscosity is preserved the more will the glass stretch. Of course, more stretchable glasses are more effective in glass lubricants. The optimum composition of the glass should be chosen in relation to the physico-mechanical and temperature conditions of pressing, and to the composition of the different alloys.

Success in pressing depends to a considerable degree on the construction of the punches and the co-ordination of their working with the rest of the components of the assembly. N. V. Perry reported that observations on the influence of movement of the glass on the surface of the punch, carried out during the production of pressings from carbon and alloy steels of more than 1,000 different profiles, showed the necessity of making special punches distinguished according to shape from ordinary punches.

In Table I are given glass compositions used for the production of metal tubes in Swedish factories.

As lubricants for steel pressing and other high melting point alloys, L. V. Prozorov used the glass formulae shown in Table II.

The lubricant made from No. 4 possessed good anti-friction properties, but gave very thin films of glass with inadequate heat insulating effects. The coefficient of friction for this lubricant lay in the range 0·03 to 0·035. Glass No. 5, used as a powder and glass wool, showed good anti-friction and heat insulating properties.

The compositions of glasses for lubricants for hot pressing of shapes made from steel, as reported by A. T. Bundin, are given in Table III.

Bundin also gave a Table, taken from "Thurmen Astor," No. 11, 1954, showing glasses for lubrication possessing, at different temperatures and with different composition, the same viscosity (Table IV).

The Institute of Glass, working on the compositions of glasses for instrument lubrication necessary in the manufacture of steel shapes, gave the following formula to the Ivotski Glass Plant which had been proved in practice (per cent): 56 SiO_2, 21 Na_2O, 0·5 Al_2O_3, 15 CaO, 3 K_2O, 2 BaO, 2·2 CaF_2, 0·3 Fe_2O_3.

Glass lubricants give the necessary effect only when applied to the punch or blank in a uniform layer of a given thickness. They may be applied to the articles by several methods. The best results are obtained by immersing the article in molten glass. Such treatment, whether the article is cold or heated up to temperature, does not adversely affect the properties of the metal which is quickly plunged into the molten glass. The technique isolates the articles from the oxidizing conditions of the atmosphere, and heating up to the temperature of the molten glass (1,400 - 1,500°C. and higher) is accomplished in non-oxidizing conditions.

The article taken from the molten glass is covered with a layer of glass, which protects it from rapid air cooling owing to the low thermal conductivity of the glass diminishing at lower temperatures.

With a suitable glass composition on the metal, corrosion does not develop and the glass covering, together with the oxide layer, comes away easily from the surface during cooling.

An original method of covering metal articles with molten glass is used in the Italian factory, Mazzarega. The articles, which are of steel, cylindrical in shape, are pushed (Fig. 1) by the plunger *A* into the kiln, touching each other. Under the action of their own weight, along the inclined channel *B*, they move to the receiving channel *C*, whence they advance to the molten glass *D*, situated on the bottom of a rotating bath.

During the rotation of the bath, the articles are heated up to 1,000-1,300°C., depending on the type of steel and their size. The bath makes one revolution per min. and is driven by a 1 h.p. electric motor. Since the heating of the article is largely accomplished in the molten glass, the surface of the metal does not oxidize. Furthermore, the oxide film dissolves in the glass and is removed together with it, which is a great advantage with this method.

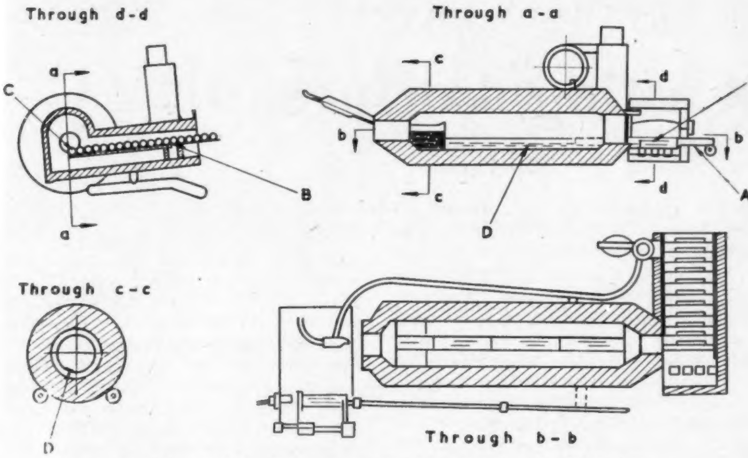
The second method of applying the glass lubricant consists of the following. On a channel inclined at a given angle for a given metal and glass, there is placed a uniform layer of glass powder about 1 mm. deep. Rolling along the channel to the box, the heated article comes into contact with the powder, which sticks to the article and melts on account of the heat in the metal. In this way the metal is covered with a layer of molten glass. This method does not ensure a

TABLE III—GLASSES FOR HOT PRESSING

No. of Glass	Content (per cent)				
	SiO_2	Al_2O_3	CaO	Na_2O	Rest
1	60	5	14	14	7
2	72	4	8	13	3
3	65	4	14	8	9

TABLE IV—GLASSES OF SIMILAR VISCOSITY

Temperature (°C)	Content (per cent)									
	SiO_2	B_2O_3	BaO	Al_2O_3	CaO	MgO	PbO	Na_2O	K_2O	Rest
600–750	27·3	—	—	—	—	—	71	—	1.5	0·2
850–1,000	69	1·2	—	3·4	6·1	3·2	—	16·2	0·7	0·2
1,000–1,100	80	12	—	3	—	—	—	4	0·3	0·7
1,100–1,200	50	7	3	21	14	—	—	—	—	5



A—Plunger. B—Inclined channel. C—Receiving channel. D—Molten glass.

Fig. 1—Mechanized kiln at the Mazzarega factory (Italy) for heating parts in molten glass

uniform covering for the metal, and is suitable preferably for cylindrical articles.

For the pressing of tubes and for the broaching bits, in place of glass powder it is possible to use glass wool or tissue. In this case, the glass covers are prepared beforehand; these are then placed on the press tools. The results here again depend on the compositions of the glass and metal.

Sometimes the glass lubricant is applied to the object for pressing in the form of an emulsion, consisting of finely ground glass and kaolin (3-5 per cent). This technique consists of heating the article to the necessary temperature, say 1,200°C., in an electric kiln or in a barium bath, and quickly transferring it to the press box, where, previously the plug of glass wool, tissue or powder had been placed. The glass melts between the hot article and the die, and covers the articles with a fine film.

In a communication on glass lubricant in the Third International Congress on Glass in Venice in 1953, I. Peishes and J. Séjournet showed that glass fibre of different thickness and composition gave dissimilar results. The structural variation of the fibre has a definite significance when used in glass lubricants.

However, in spite of the many formulae given for use as lubricants there is, as yet, very little data which establish the technological and physico-chemical laws of the reactions between glass lubricants and metals.

Ageing Nickel Alloys

ACCELERATED ageing of the heat - resistant nickel alloy EI437B has been accomplished by means of ultrasonics, according to an article in *Metallovedenie i Obrabotka Metallov* (Russia).

Ultrasonic vibrations with a frequency of 20-26 kcs were used and the investigations provided values for changes in hardness during ageing, stresses, and hardness after ageing relative to various heat-treatment procedures. A two-fold increase in ultrasonic energy enabled ageing time to be reduced 40-50 times relative to ageing by conventional means. The use of ultrasonics during ageing at 800°C. made it possible to eliminate the effect of phase coagulation and to increase hardness values 15-20 times more rapidly than by usual age-hardening methods.

Wire Drawing Economy

A LEADING American cable company that operates a wire drawing machine 24 hr. a day, five days a week, to draw copper wire to about 0·020 in. (0·51 mm.) in diameter, has effected savings around $1,500/year by flame plating the aluminium alloy pulleys. The machine has seven 5 in. (12·7 cm.) diameter aluminium pulleys, used in the annealing cabinet and on the tension arm, which operate at from zero to 5,000 r.p.m. Some of the pulleys are subjected to a waterspray bath. The aluminium pulleys serve two purposes: corrosion resistance, and low inertia to reduce wire breakage due to starts and stops. Unplated pulleys had a life of 10 working days. Now, the company has the seven pulleys flame-plated and, as a result, obtains a service life of 10 months per pulley—a 2,000 per cent increase.

The flame-plating process is a surfacing method in which particles of tungsten carbide are literally blasted on to the surface of the workpiece. Equipment used in the process is produced by Union Carbide International Co., New York.

Alloying Additions

EFFORTS to improve the methods used for adding alloying elements to melts of aluminium alloys have led to an agreement between Murex Limited, Rainham, Essex, and a West German manufacturer for the production and sale in the U.K. and Commonwealth of alloy tablets based on manganese, chromium, titanium, antimony, copper, etc.

These tablets eliminate the "hardener" stage altogether, and not only are the undesirable aspects of "hardeners" eliminated by the use of alloy tablets, but many positive advantages can be claimed.

The tablets, with a few exceptions such as silicon and magnesium, have a high specific gravity and are self-sinking. They do not, therefore, need mechanical aids such as plungers.

Slight turbulence caused by the tablets going into solution lead to a homogeneous distribution of the alloying element, at the same time enabling such elements already present to be more thoroughly distributed. The holding time required to allow the element to go into solution is cut down to a very short period, and thus labour and fuel costs are reduced, with the complementary advantage of enabling increased production to be achieved from a single furnace unit.

Little or no mechanical stirring is necessary, thus dross is virtually eliminated. No additional heating is required to put the element into solution, since the tablet is exothermic in its action, and up to 100 per cent recovery of the alloying element can be expected. Cleansing and grain refining properties of the tablets are considered, by some users, to be the prime advantages, and the removal of contaminants results in improved flowability and castability.

The element concerned is incorporated in the tablets to give a fixed weight of useful content, which makes the weighing and observation of changing composition unnecessary. The form in which the element can be added, and the speed of solution, enable final corrections to analysis to be achieved easily.

Obituary

Mr. E. G. Pickering

IT is with regret that we record the death of Mr. E. G. Pickering, a joint managing director of Johnson, Matthey and Co. Limited. Mr. Pickering, who was 59, had been ill for a long time.

Mr. T. A. Trumbour

IT is also with regret we announce the death of Thomas A. Trumbour, general manager of Metals and Plastics Publications Inc., publishers of our American contemporary *Metal Finishing*, with which journal METAL INDUSTRY has always had the closest association.

Research Progress

Slip Casting Cermets

BY RECORDER

POWDER metallurgical techniques in the manufacture of components made of high melting point materials, metastable alloys, and so on, supplement more conventional methods of casting and fabrication. The former techniques also have disadvantages and limitations, however; for instance, specialized equipment for powder pressing is expensive and complex shapes (and some simple forms of particular geometry) are difficult or impossible to make. Thus, although powder metallurgical processes make possible the development of cermet materials, i.e. mixtures of metals and ceramics which, by their nature, are generally not amenable to more usual methods of manipulation, other techniques have to be employed for certain compositions or components. Among these is the "slip" casting process, the application of which to the cermet field has been described[1] by L. M. Schifferli, of the Union Carbide Corporation.

Besides the normal requirement for a mould material—that it should retain with precision the shape of the former—moulds for slip casting must be absorbent and strong when moist. Plaster of Paris is suitable, but to obtain the best results the steps in making the mould must be controlled—particularly the mixing of the initial slurry. Schifferli maintains, however, that "plaster mould making is somewhat of an art."

In describing the making of a slip, Schifferli first discusses the properties of clay-based ceramics that have been slip cast for some time. These minerals have a very fine particle size and when added to water, produce a thick paste. The presence of electrolytes, however, can give a high dispersion by adsorption and ionic repulsion, and the viscosity is greatly reduced thereby. Settling is not severe because of Brownian movement, so the slip so produced is stable over reasonable periods of time.

The essential features required are thus raw materials of extremely fine particle size and the presence of a dispersing agent. The components of a cermet can be produced in fine powder form either by attrition or by special methods of manufacture. Thus, the ceramics can often be made by low temperature calcination, which gives the desired fine product: alumina with an average particle size of about 0·3 microns can be obtained in this way. Fine metal powders can sometimes be produced by hydrogen reduction methods or, as in the case of chromium, by ball-milling electrolytic powders. The surface area and density of the individual particles are clearly important factors, determining the dispersive characteristics of the powder.

In making a cermet slip containing, for example, 77 per cent chromium, 23 per cent alumina, the alumina powder is gradually added to water containing the dispersing electrolyte (dilute mineral acid) in a high-speed mixer. The colloidal suspension so obtained contains up to 60 per cent solids by weight and must be diluted before the chromium powder is added. The dispersion of the slightly larger and heavier chromium particles is assisted by the presence of the alumina suspension, and the solids content of the final slip is usually over 80 per cent. Such alumina:chromium dispersions can be poured freely and stored almost indefinitely, as settling affects only the percentage solids in any fraction and not the Al_2O_3:Cr ratio.

The slip, when poured into a dried mould, quickly loses its liquid content and the solids build up on the mould walls. The rate of "solidification" is important and must not be too fast, otherwise imperfect surfaces may result and the solid shape tends to adhere to the mould. A slight shrinkage away from the mould wall occurs at solidification times longer than about 10 min., and this assists in freeing the casting. If hollow shapes are required, the solidification can be allowed to proceed to the desired wall thickness, and the remaining excess slip poured out for re-use.

As might be expected, the "castings" so produced are fragile. The strength is a function of powder particle size, slip mixing technique and the dispersing agents used, but again Schifferli gives no details of the relationships between strength and the variables mentioned. The component must be sintered after complete drying and, since the cermets are refractory and resistant to change at normal and moderate temperatures, high sintering temperatures are required. Thus, for the Al_2O_3 : Cr mixture mentioned earlier sintering is carried out at about 1,565°C. in an inert atmosphere. The sintering of the porous casting causes considerable shrinkage to occur—presumably much greater than that usually encountered in powder metallurgical work. This dimensional change, unlike that occurring after cold-pressing, however, is not influenced by the factors causing heterogeneous shrinkage, and relative dimensions remain constant. Nevertheless, tolerances can seldom be kept to better than ± 3 per cent, though accurate dimensions can be obtained by subsequent machining.

Schifferli gives some of the properties of three metal-ceramic mixtures after slip casting and sintering. The compositions considered were 77 Cr-23 Al_2O_3, 59 Cr-20 Mo_2-19 Al_2O_3-2 TiO_2, and 60 W-25 Cr-15 Al_2O_3. The three materials had densities 95, 92 and 91 per cent of the theoretical values respectively, the last having the high value of 0·32 lb/in^3 The thermal expansion of each was moderate (all lying in the range $4{\cdot}64$–$4{\cdot}95 \times 10^{-6}$ in/in/°F.), as were also the thermal and electrical conductivities. The oxidation resistances at 1,205°C. are given (apparently on the basis of 100 hr. tests) as 0·165, 0·095 and 37·5 in/yr. respectively. In tests which presumably simulated service conditions of thermal cycling, these values changed to 0·131, 0·159 and 231·0 respectively. The poor resistance of the high-tungsten material is clear, and it could be used at temperatures of this order only under favourable atmospheres.

The three cermets were all brittle, but each had "adequate" thermal shock resistance. Normal tensile properties could not be obtained, but bend strengths were measured at room and elevated temperatures. The moduli of elasticity at room temperature were 37·5, 38 and 38×10^6 lb/in^2 respectively, and at 980°C., 33, 31 and 33×10^6 lb/in^2 respectively. The room temperature transverse strengths were approximately 20, 25 and 32·6 tons/in^2 respectively. The low resistance to oxidation of the high tungsten material precluded elevated temperature tests, but the other two cermets retained a considerable fraction of the room temperature strength at 1,000°C. and over. Thus, the Al_2O_3:Cr material had transverse strengths of approximately 11·8, 7·4 and 2·0 tons/in^2 at 980°, 1,150° and 1,315°C. respectively, and the Cr-Mo-Al_2O_3-TiO_2 of 24·4, 12·9, and 5·3 tons/in^2 at these three temperatures respectively.

The Paper concludes with a comparison of the slip casting-sintering technique with the two other main methods of manipulating cermets and similar materials—powder metallurgical processes and extrusion. The two principal advantages adduced are low capital cost and the facility with which quite complicated shapes can be made. Among the disadvantages in commercial production are the fragility of the as-cast shapes, the large sintering shrinkages and the high sintering temperatures needed.

Reference

[1] L. M. Schifferli; *J. Metals*, 1958, **10** (8), 517.

INVESTMENT CASTING PRODUCTION AT DROITWICH

Deritend Precision Castings Ltd.

By W. NEVILLE JONES

This week, delegates to the Golden Jubilee Autumn Meeting of the Institute of Metals are visiting a number of works in and around Birmingham. The two firms described here, Deritend Precision Castings Ltd., and the Metals Division of I.C.I. Ltd. at Witton, are among them.

FORMED early in 1948 as a subsidiary of the Deritend Stamping Co. Ltd., Deritend Precision Castings Ltd. was first housed in an old three-storey granary building adjacent to the parent company's registered office and works in Birmingham. This building was inconvenient but it served its purpose and, after considerable structural modification, machines were installed and production started in June, 1948. The first castings were sold in the August and a determined effort was made to seek orders.

At first these were slow in forthcoming. Before many customers were convinced of the value of investment castings samples had to be supplied, and in some cases these were under test for periods up to eighteen months in machines working under normal conditions. However, work slowly flowed into the factory and in 1951 orders were received in substantial numbers, so that it became apparent that an expansion would have to take place to cope with the demand for castings.

No additional space being available in Birmingham, a site was eventually chosen at Droitwich, where a 15,000 ft^2 factory was built in 1953.

The layout of the factory was carefully planned to ensure an even flow of work from stage to stage of the process, and great use was made of ideas contributed by the workpeople, who showed considerable interest in the project.

Labour was recruited in Droitwich several months before the move was planned to take place, and these people were trained in Birmingham. In addition, arrangements were made to transfer all key personnel to Droitwich, so that a strong nucleus of trained labour was available when the factory was completed.

When planning the factory, consideration was given to future expansion and the building was designed for extensions to be added without upsetting existing arrangements, and this turned out to be a wise move.

Production commenced at Droitwich in November, 1953, and after the inevitable teething troubles encountered with new plant of novel design, the output increased to an extent that led the board to consider a further extension. After the initial move from Birmingham, use continued to be made of the parent company's laboratory and test house, and their heat-treatment department. Transporting large numbers of castings to Birmingham each day, however, involved difficulties and a decision was, therefore, made to provide these facilities at Droitwich. Accordingly, a new bay was added, and heat-treatment and testing commenced at Droitwich in the summer of 1957.

Work also commenced on new offices and works accommodation, making use of the provision for expansion already mentioned, and this was completed in the spring of 1958, resulting in a building whose complete floor area covers approximately 30,000 ft^2.

The factory stands on a three-and-a-half acre plot between the main A.38 Birmingham-Bristol road and the Western Region Birmingham-Cardiff railway, thus having excellent communications.

As a point of interest, the site is also occupied by the foundations of a Roman villa which was discovered during the building of the original factory. It was excavated and thoroughly examined by a party of archaeologists from Birmingham University during the summers of 1954 and 1955.

In the "lost wax" process, a wax pattern is required for every casting produced, and these patterns are made in dies similar to plastic injection moulds. A number of the patterns are mounted together on a wax feed bar, or "riser," as this is known, to form an assembly. This assembly is sprayed or dipped with a highly refractory slurry to form a primary coating; a secondary refractory slurry is poured to "invest," or completely surround, the assembly, forming a mould which is dried. After drying, the wax is removed by melting and burning, leaving clean cavities into which metal can be poured, either by gravity or under pressure. After casting, the

The wax department in which patterns are made and mounted together on feed bars

mould is cooled and broken open, leaving an assembly of castings which, after being cut away from the risers, are trimmed, shot-blasted, and sent to heat-treatment and inspection, whence they are ready for despatch.

The process is extremely versatile, in that intricate shapes of small and medium sizes, varying in weight between a fraction of an ounce and several pounds, can be produced to tolerances of $\pm 0{\cdot}005$ in/in.

The factory is laid out with the idea of creating an easy flow of work, stage by stage, through the process, to ensure a minimum amount of handling. Administrative offices and the drawing office are concentrated at the south end of the building, occupying one bay of the structure. The plant is contained in eight further bays, with north lighting, each measuring 112 ft. 6 in. by 30 ft. span.

Considerable use is made of compressed air at 100 lb/in^2, and the compressor house is situated in the centre of the building with the idea of reducing the length of air lines to a minimum.

Heating, apart from office spaces, is by hot air convectors slung at truss level, the air being fanned through radiators fed by hot water from two oil-fired boilers at the north end of the factory. Additional heating is obtained by utilizing waste heat from furnaces in the foundry.

Raw materials for each department are located in individual stores, each having direct access to the apron road which skirts the factory.

The first bay contains the tool room, tool stores and maintenance area. The buying office and general stores are also located in this bay.

Tools or dies are manufactured by two alternative methods, either by casting in a tin-bismuth alloy round a master model, or by conventional machining, depending on the nature of the component. Each method has certain advantages, and when considering a new job the type of die has to be decided. In the event of a cast die being decided upon, a master model, suitably oversize to allow for contraction, has to be made from brass or mild steel. This model is exactly like the finished casting, apart from being approximately 2 per cent oversize. The tin-bismuth alloy has the virtue of neither expanding nor contracting on cooling, and reproduces faithfully all the detail of the master model. After casting, the model is removed from the dies, leaving an impression in each half. Dowel pins, ejector pins, backing plates, etc., are fitted, and the dies are ready for producing wax patterns.

In addition to die production, the tool room manufactures all tools for subsequent operations, and gauges for the finishing and inspection departments.

Wax patterns are produced on wax injection presses operated pneumatically. In these presses, hot wax is contained in cylinders surrounded by a water jacket to maintain the wax at constant temperature in a plastic condition. When they are operated, the wax is forced through a further cylinder under pressure into the die impression. The wax cools rapidly, and on parting the dies a perfect wax pattern of the component is obtained. The wax injection presses are designed for a high rate of production but this, naturally, varies with the size of pattern being made.

A natural wax is used for patterns, and it is normally stained green to assist inspection. Requirements for a pattern wax are low contraction rate on cooling, rigidity, and a low ash content. Rigidity is important, as any distortion of the pattern will be reproduced in the casting.

Patterns are inspected after removal from the press and then welded with electrically-heated irons to feed bars or "risers," mounted on cast aluminium base plates. A dome in the base plate, into which the vertical riser is affixed, forms the feeder head in the mould at a later stage. The patterns mounted on their bars form an assembly which is the basis of the mould into which metal will eventually be cast.

After mounting and further inspection, the complete assembly is placed, along with others, on a rack suspended from a mono-rail, whence it is taken into the investment department.

This occupies the next bay and contains a spray booth for applying the primary coating, mixer, vibrators and drying ovens.

Wax assemblies are dipped and sprayed with a primary coating, which consists of a finely divided (300 mesh) high-grade refractory held in suspension in a medium which facilitates adequate covering of the wax. This primary coating is equivalent to the facing sand of a conventional mould and is instrumental in giving castings the fine finish which is one of their characteristics. A thickness of approximately 0·015 in. is normal and, after spraying, the assembly is "backed off" with a coarser refractory powder to provide a key for the mould refractory to adhere to the coating.

Sprayed assemblies need to be dried before being invested, otherwise the refractory slurry used in investment would tend to wash the coating from the wax. Drying is carried out in batches, in a battery of chambers whose temperature and humidity is controlled. Batches of sprayed assemblies are sealed in the chambers until required for investing.

As explained above, "investing" is the process of manufacturing the mould. To accomplish this, a rectangular, slightly tapering container, open at top and bottom, is placed

View of the foundry and investment department looking towards the melting units

carefully over the assembly and locked to the base plate, forming a box containing the assembly. Into this is carefully poured a slurry roughly of the consistency of porridge, so as to completely cover the assembly.

This slurry consists of a refractory, usually silimanite, with a liquid bonding medium, and it is produced in a mixer similar to those used for mixing concrete. Tetra-ethyl-silicate is used as a binder and this, under the subsequent action of increased temperature and a suitable catalyst hydrolyses, forming a silica gel which binds together the refractory particles, thus setting the mould. After the container is filled it is placed on a vibrator, which causes the particles to pack together firmly.

Moulds are vibrated for a time determined by experience, and at the end of the vibration period the refractory has packed down hard around the assembly. Fines and surplus liquid rise to the surface and are poured away, whereupon the invested assembly in its container is transferred to a low temperature, electrically-heated oven., where gelling of the tetra-ethyl-silicate takes place. A minimum of 12 hr. is allowed for this stage of the process.

After gelling, the invested moulds are hard and firm, and capable of withstanding their own weight when handled, so that the containers and base plates can now be stripped off. Containers are removed from the moulds pneumatically and, to facilitate removal, are slightly tapered, as mentioned above.

The stripped mould still contains the wax patterns which, having completed their purpose of forming cavities in the refractory are no longer required. Consequently, the moulds are transferred to further ovens, similar to the drying ovens but operating at higher temperatures, where much of the wax melts and runs out of the feeder head (at this stage still in the inverted position). The wax is caught in trays, refined and used again for risers. No reclaimed wax, however, is used for patterns, to avoid the risk of inclusions which might result in scrapped castings.

Unfortunately, all the wax does not drain from the moulds at this stage; a proportion is always trapped in the cavities and, since it is essential for the latter to be absolutely clean, this trapped remainder must be removed. Removal of this wax is achieved by burning in furnaces designed to produce an oxidizing atmosphere.

These furnaces are situated in the foundry, which occupies the next two bays. Three furnaces are gas-fired batch type semi-muffles, while the fourth is a gas-fired tunnel having a 20 ft. moving hearth.

Moulds are given a long soaking in these furnaces to ensure complete removal of all carbonaceous matter. The firing also serves to strengthen the moulds and to raise them to their casting temperatures. All moulds are hot when cast, to facilitate running the metal, and mould temperature is critical, depending on the particular alloy being cast and the shape and cross-section of the casting.

The melting units occupy the north end of the foundry and comprise high-frequency generating sets, each with its individual crucible. Each furnace consists of a crucible surrounded by a water-cooled copper coil carrying high-frequency current, the whole being enclosed by refractory to protect the coil in case of breakage. These units are mounted in trunnions and arranged so that a mould can be clamped to the top of the unit, its feeder head against the crucible, and the whole assembly inverted for casting.

A normal melt is 10-11 kg. in weight, and the metal is carefully weighed so as just to fill a mould when cast.

Base metal is preheated to a dull red heat in a gas-fired muffle before being placed in the melting unit, in order to speed operations, and it is normally handled in the form of bars up to 1¼ in. diameter and 10 in. long. Incoming metal supplies are carefully controlled and specifications held to extremely close limits in order to achieve optimum mechanical properties.

Although high frequency melting involves greater capital expenditure, it has many advantages over other methods. Speed of melting, close temperature control, ease of slagging and the avoidance of any risk of carbon pick-up in the melt are among some of the more obvious advantages.

Melt temperatures are checked and recorded by immersion pyrometer.

Moulds can be gravity cast or pressure can be applied. After casting, the mould is allowed to cool and is broken open, revealing an assembly of castings identical with the original wax assembly. Refractory is vibrated off the assembly, which is then passed to the cut-off section.

The used refractory is pushed through a steel grille in the floor, where it passes through a crusher sited underground. This breaks it up into its original-sized particles, but is so arranged that the grains themselves are not crushed. An elevator then takes the refractory up to a series of sieves, where it is graded and returned to the investment department.

Castings are normally cut from the riser bars by a high-speed friction band saw, although certain heavy castings may be cut on abrasive wheels.

The cut-off section also deals with bar material, cutting it to length suitable for the foundry to use. Scrap metal from the assemblies is cut up here and placed in the adjacent metal stores for despatch to the refiners.

After cutting the castings from the assembly, they require their feeds trimming and this, together with other small finishing operations, is carried out in the next bay.

Castings are first shot-blasted to remove any adhering refractory, and they are then passed to small 6 in. abrasive wheels, where the feed is removed. Any vestige of feed left on the casting is then trimmed on bench grinding wheels. Small pneumatically-operated grinders deal with any possible local blemishes, and castings are then ready for radiological examination and heat-treatment.

X-ray examination is not carried out on the premises but great use is made of it and, of course, on a majority of castings destined for aircraft it is mandatory. All new work is X-rayed before submitting samples to the customer, to ensure that the casting technique is satisfactory, and a room in the laboratory is laid aside specifically for screening negatives.

The heat-treatment department in the last bay contains salt-bath furnaces, gas-fired semi-muffles, and an electrically-heated air-recirculating furnace. With the aid of these, hardening, tempering, normalizing and annealing are carried out, together with solution treatment and ageing when required.

Here, again, strict control is essential; the structure of castings cannot be modified by the type of mechanical work that forgings or bars undergo, with the consequence that all modifications such as grain refinement must be accomplished thermally.

In the same bay, and adjacent to the heat-treatment shop, is the test house. Here, test bars are turned, and routine tensile, impact and hardness tests are carried out, in addition to investigations into the properties of new alloys, etc.

The chemical laboratory adjoins the test house and this is well equipped for all routine analyses, as well as investigations.

After heat-treatment, castings are again shot-blasted lightly, and then visually and dimensionally inspected. This department, again, is adjacent to the laboratory and finishing departments. Inspection is required to be rigorous when dealing with castings produced to close limits, and precautions must be taken which would never concern a conventional foundry. This department is also responsible for non-destructive testing, and among its equipment are facilities for crack detection by magnetic and other methods.

Castings finally pass from inspection to despatch, a room again adjacent, so ensuring a minimum amount of handling.

A wide range of alloys is cast, although most work is undertaken in steels and the heat-resistant and abrasion-resistant alloys, such as Stellite and the Nimonics. Typical steels include case-hardening, mild and medium carbon, and medium carbon alloy steels. In this latter category fall the high tensile steels of chrome-molybdenum type, giving tensile strengths up to 85 tons/in^2. Stainless steels, both hardenable and austenitic, and heat-resistant steels, are produced in quantity.

Other alloys cast at Droitwich include beryllium copper, brasses, phosphor bronze, and gunmetal. A limited amount of work in aluminium alloy is also undertaken.

A considerable volume of the work embraces castings for aircraft, and the firm is approved by the A.I.D. and A.R.B. It also carries approval by the Ministry of Supply for the manufacture of high-tensile steel castings for aircraft in such specifications as D.T.D. 666, 705 and 5072.

To meet these exacting requirements, stringent control has to be applied at all stages of the process, and the enthusiasm of a young staff has, throughout the history of the company, ensured these controls being maintained.

Much of the equipment has been designed and built in the works, for in so new an industry it simply cannot be procured elsewhere; and development is continually being carried out with the object of improving both the process and the plant.

Imperial Chemical Industries Ltd., Witton

By W. H. HODGETTS, M.I.Prod.E.

EVERY year, many thousands of tons of non-ferrous metals—mainly copper, brass, aluminium, titanium, and zirconium in the form of sheet, strip, tube, rod, plate, and wire—are despatched by I.C.I. Metals Division to customers in the United Kingdom and abroad. Employing over 15,000 people in fifteen factories, I.C.I. Metals Division is the largest producer of wrought non-ferrous metals in the Commonwealth.

I.C.I.'s non-ferrous metal interests derive from the merging, between 1918 and 1934, of a number of prominent companies in the industry, and their subsequent unification into a single organization catering for practically all aspects of the trade. Through these firms, direct ancestry can be traced back to the Swansea copper smelters and refiners of the eighteenth century and to the early days of the Birmingham brass trade.

Through its own wide resources, I.C.I. has been able to keep in the forefront of technological progress, to foster extensive research and development, and to lay down melting, rolling, drawing and extrusion plant of the most modern design.

Some of the Division's largest production units, as well as the administrative headquarters, are located at Kynoch Works, Witton, Birmingham.

Strip Mill

Two features distinguish I.C.I.'s strip rolling activities—the extensive use of mechanical handling equipment in support of mass-production flow-lines, and the comprehensive quality control accompanying every stage of manufacture.

More than 25 years ago, the main strip mill was among the first British units to cater for the hot rolling of half-ton brass slabs—a lead which has been maintained by progressive installations of the latest plant to become available.

To-day, copper and copper alloy strip and sheet are produced from ½ ton rolling slabs. Copper alloy slabs, 4 in. thick, are cast from Ajax-Wyatt low frequency induction furnaces into copper-faced water-cooled moulds. Samples of the melt are sent to a quality control laboratory for analysis, and only when a satisfactory release certificate is received are the slabs passed on to the mills.

After "gating," slabs are preheated in gas-fired furnaces and conveyed mechanically to the roller tables of a 2-high reversing mill where, in a few passes, the slabs undergo reductions of up to 90 per cent in thickness. After this initial hot breaking-down, the strip is transferred to a Torrington milling machine for surface overhauling, to ensure that a high-class product goes forward for subsequent cold-working operations.

The strip is then cold-rolled on 4-high mills, which reduce the thickness with intermediate anneals to 0·080 in. in coil form. Annealing is carried out in a continuous electrically-heated tunnel type walking beam furnace.

The cold rolling bay, where strip is rolled to finished gauge as low as 0·003 in., and at speeds up to 1,000 ft/min., contains many interesting items of modern plant.

The various high-speed finishing mills are fitted with "flying micrometers," beta-ray or X-ray gauges, together with controlled coiler/decoiler tensioning devices to ensure the production of strip of uniform thickness both in the length and across the width. Continuous annealing and cleaning methods are used, including a Drever vertical electric annealing furnace. Controlled atmosphere furnaces, utilizing cracked and burnt ammonia gas, are used for the final bright annealing of copper.

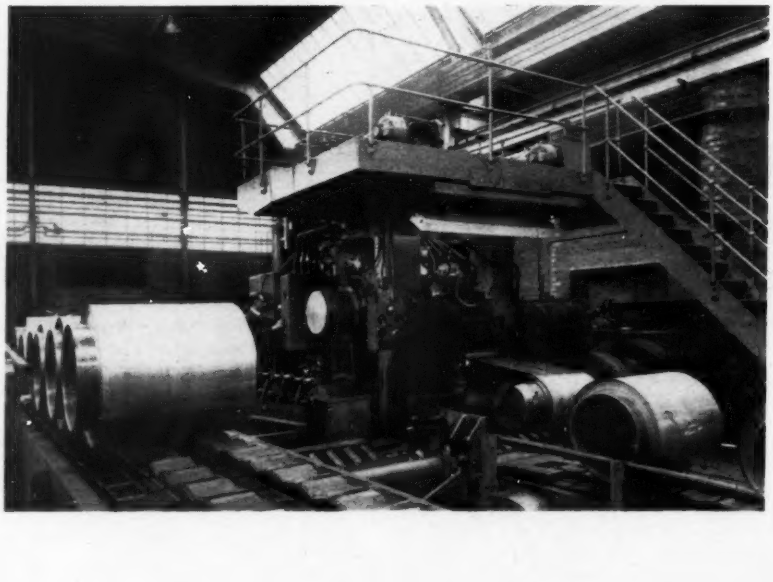
It will be appreciated that modern high-speed rolling plant can only be utilized to the best advantage by rolling strip in the longest possible lengths and maximum widths. Accordingly, the mill is equipped for argon-arc welding of three smaller coils to give large coils up to 3,000 lb. weight. These are rolled down to finished gauge mainly in the full width of 24 in., after which they are cut to ordered sizes. The achievement of accurate gauge control across the full width and throughout the length of so large a coil is largely due to the fundamental research work carried out by the Division into the theory of roll cambers and roll design.

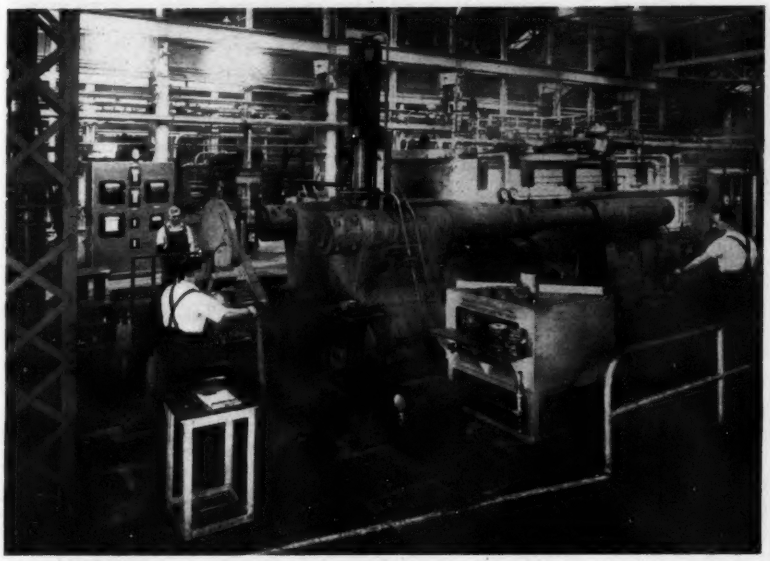
Rotary slitting machines of modern design shear coils to process and finished widths. Equipment embodying a photoelectric cell for detection of pinholes in radiator strip is also available.

Quality control is maintained by patrol inspection during all processes, and for some special lines every coil is run out and the surface of both sides examined during final inspection.

The need for the speedy and efficient handling of heavy coils was appreciated when the mill was

One of the Davy and United 4-high high speed cold strip mills





A Loewy 2,500 ton press for extruding brass sections

designed, and handling facilities and flow lines are most impressive. Reversible slat conveyors carry coils from the coil storage and shearing sections to the cold rolling bay, and connect with the annealing furnaces. Each bay has one or more rigid mast cranes, some capable of lifting up to 3 tons at a time. Roller track conveyors, electric hoists, pneumatic lifts and fork lift-trucks reduce normal handling to a minimum.

Rod Mill

Although rods and sections are made by I.C.I. Metals Division in many different metals, including aluminium, titanium, zirconium and their alloys, the largest rod-producing plant is devoted to copper and copper alloys. Materials constituting the output of this mill include high-conductivity and phosphorus-deoxidized copper, and a wide range of brasses developed to yield specific properties.

In addition to simple round, hexagon and square rod, some 6,000 differently shaped sections can be supplied.

As in other foundries in the Metals Division, the bulk of melting is done in large Ajax-Wyatt low-frequency electric induction furnaces, with the charges containing a proportion of process and other scrap. Exceptional facilities are provided for the storage, grading and identification of the various types of scrap, and for close control of the resulting castings, by chemical and spectrographic analysis. The castings are in the form of round billets, 5 in., 7 in. or 9 in. in diameter.

Extrusion into rods or sections is carried out on a series of horizontal hydraulic presses with capacities up to 2,500 tons.

Billets are pre-heated in gas-fired inclined-hearth furnaces or high-frequency electric induction furnaces. Extrusion temperature varies according to composition, but generally lies between 700°C. and 850°C.

After extrusion by the conventional direct process, bars and sections required to specially accurate dimensions, or for special mechanical properties, are pointed by machining, milling, rotary swaging, hot forging or push pointing, according to the weight and intricacy of the design, and drawn to the final size. These drawing operations are carried out either on general type chain benches, wire blocks, or on "Schumag" composite machines which draw, cut to length, and straighten in one pass.

Larger diameter round rods, hexagon and square rod, and some simple sections, are straightened on multi-roll straightening machines or on stretching machines. Complicated sections which cannot be satisfactorily straightened by one of these methods are hand-straightened by a skilled operator. Low temperature annealing or "reeling" is employed to relieve internal stresses.

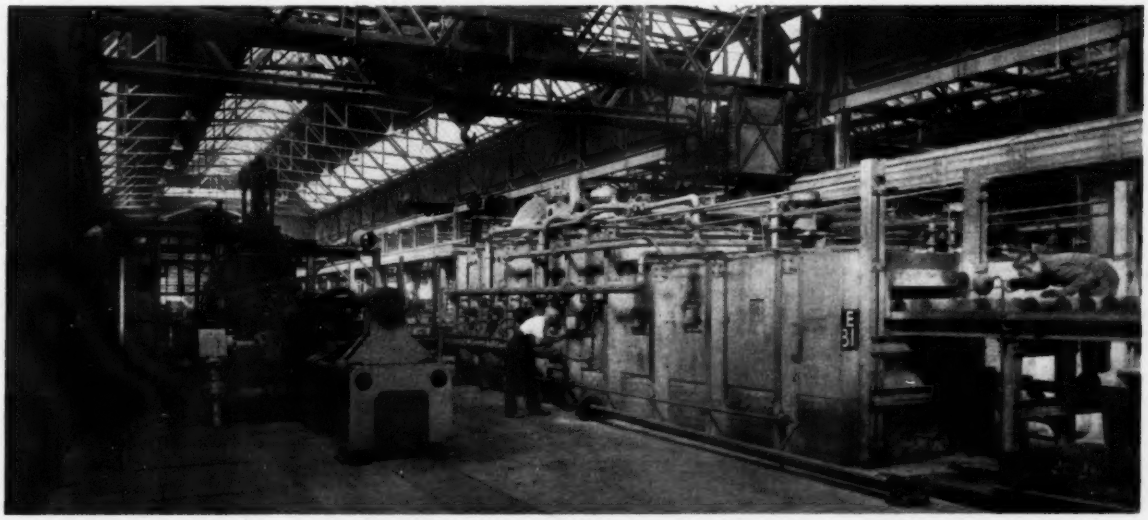
At all stages, patrol inspectors keep a close watch on surface and dimensions. Checks for internal soundness are made before material is cut to finished length, and all output receives a final overall inspection before despatch.

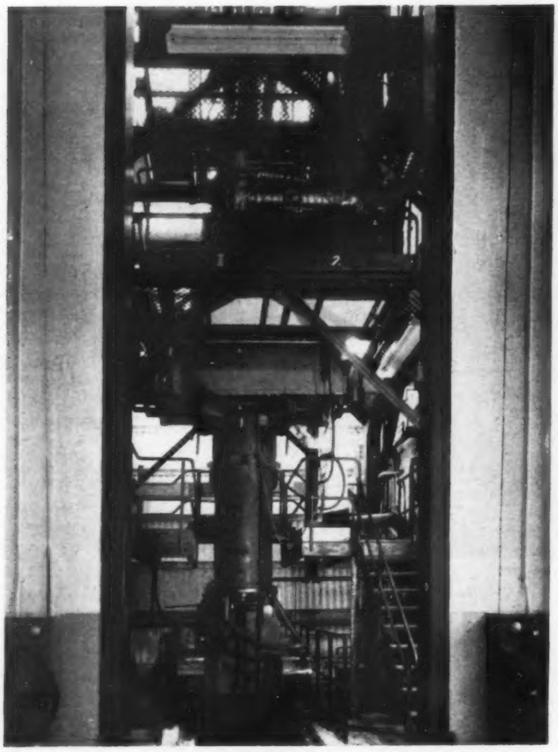
Titanium Melting Plant

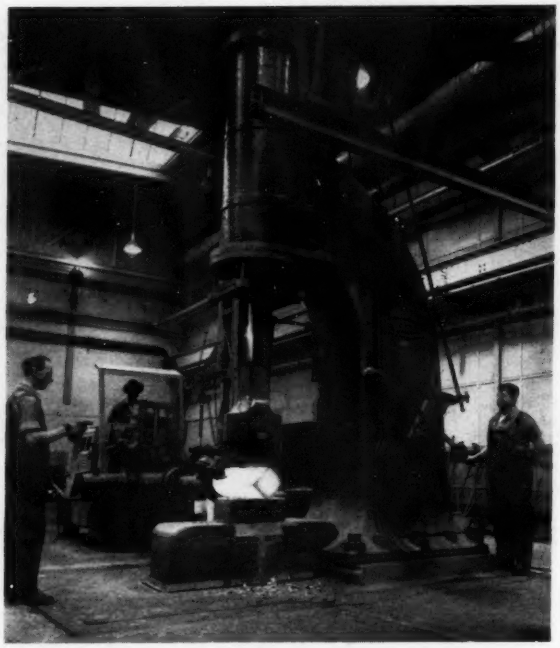
It would be difficult to imagine a greater contrast than that between the conventional non-ferrous metal foundry and this plant for melting one of the "newer" metals.

The reason for this startling evolution is that titanium cannot be turned into massive form by normal casting methods. Titanium has a very high

The pre-heat furnaces that feed the extrusion presses







Above : Forging titanium

Left : The Heraeus titanium melting furnace

melting point—nearly 1,700°C., or 200°C. higher than that of steel—and, in its molten state, combines with any of the materials normally used to line a high temperature furnace. In addition, molten titanium will absorb gases (oxygen or hydrogen, for example) which have a deleterious effect on its physical properties.

I.C.I. Metals Division was the first firm in Britain to overcome these difficulties and so make possible the commercial production of an immensely useful structural metal. The first difficulty, that of the high melting point, was solved by using the intensely high temperature of a powerful electric arc within the furnace. The problem of containing the metal while it melted was solved by designing a copper crucible enclosed in a water-cooled jacket, that of contamination by melting either in vacuum or in inert gas such as argon.

Technical progress has been so rapid that, since the first commercial-scale melting plant was commissioned in 1955, the furnaces have been replaced three times. At that time, eighteen furnaces were needed for an output of 1,500 tons a year and the size of ingot was limited to 400 lb. Now, 2,000 tons a year can be produced in ingots weighing 2,100 lb. or 4,200 lb.

The total output is produced by three furnaces, built by W. G. Heraeus G.m.b.H., Western Germany, and commissioned in March of this year. Incorporating many important technical improvements, they operate the same technique of double arc melting as the original small furnaces; a consumable electrode has for some time been used in place of the graphite electrode of the early days. Because titanium melting is subject to hazards not encountered with more conventional metals, all operations are carried out by remote control. Each furnace is built inside a massive 60 ft. high reinforced concrete cubicle, and before melting starts this is "sealed" by a 10-ton door. As soon as the furnace is fully assembled for melting, control is taken over by a single operator in the control room.

The electrode which will melt to form the ingot is made by compacting raw titanium granules (produced by I.C.I. General Chemicals Division), mixed when necessary with other powdered metals to make alloys. To ensure thorough blending, the powder passes through a double-cone mixer and a "splitter" before it is fed into the die of a 2,500 ton press. This compresses the powder into a solid semi-circular cake, which will form one section of the electrode. Completed sections are carried along twin-track rollers; when sufficient sections to make up the full weight of the electrode are ready, welding completes the formation of an electrode 12 ft. long and weighing almost a ton.

For melting, the electrode is lifted by crane into a copper crucible mounted on an electric truck, which carries it into the furnace cubicle. The crucible is then clamped to the underside of a vessel which covers the exposed length of the electrode, and pumps immediately begin evacuating air, so that the two containers together form the vacuum in which melting takes place. An overhead ram controls the downward movement of the electrode as it melts.

A special feature of the Heraeus furnace is the locking device which enables the first-melt ingot to be lifted and held, still in vacuum, while the crucibles are changed for the second melt, thus economizing on "down time" and ensuring maximum furnace utilization.

The progress of the melt is watched in the control room by means of a direct optical system which reproduces a picture of the electric arc, and with the aid of measuring and recording instruments. In the two to three hours required to melt a one-ton ingot, the operator makes any necessary adjustments to electric and magnetic circuits and pressure systems.

The further processing of titanium into wrought form follows a more conventional pattern. "Dressed" to remove surface blemishes, the ingot is heated in an electric furnace for forging into slab or billet. Heating to forging temperature must be done with extreme care, because at such temperatures the surface of the metal oxidizes, forming a layer which has to be removed after forging by shotblasting or machining.

The bulk of the output of the titanium melting plant is processed into sheet or rod at the company's new factory at Waunarlwydd, Swansea. Other wrought forms, including tube, wire and extruded sections, are fabricated on conventional plant elsewhere in the Division.

(To be concluded)

Industrial News *Home and Overseas*

Diverting a River

During the past few days, the River Ebbw, as it flows through the parish of Rogerstone, has taken a new course. For a quarter-of-a-mile it will follow a channel made by man and eventually its old bed will be filled in and lost. **Northern Aluminium Company Limited** have felt the need of additional ground for further expansion, and by straightening the river as it meanders past the west boundary, the company will gain about 7 acres on which new productive plant can be installed.

For some weeks, the earth-moving equipment of the contractors has been scraping out a new 65 ft. wide river bed—several feet wider than the old one. A dam had been left at each end of the channel to contain the river, which is now higher than normal, and in the last stage of the operation these dams were removed and the river took its new course. Filling in of the old bed will take place later.

As announced by the chairman, Lord Alexander, in May last, the company plans to spend £10 million over the next four years, the major part of which will be used for the expansion of the rolling mill at Rogerstone, raising its annual capacity to 75,000 tons. This will be done in such a way that further increase in capacity to 175,000 tons a year will be possible at a relatively low cost per ton.

Annual Report

Published yesterday, the annual report (1957-58) of the **British Welding Research Association** makes interesting reading. Within its 62 pages, details of fundamental research are given, also of ferrous and non-ferrous research, engineering research, the board, and various committees and the like. In the non-ferrous section, reference is made to research in medium-strength aluminium alloys; high strength heat-treatable aluminium alloys; gas-shielded arc welding of copper; welding of aluminium bronze; titanium alloys, and zirconium alloys.

Appointment of Agents

It has been announced by **Flexibox Limited** that they have appointed John Turner and Company, of 25 Collingwood Street, Newcastle upon Tyne, as agents for the North-Eastern area of the country. Mr. G. L. Towers, B.Sc., has joined the company as sales engineer, and will be based on Birmingham, being responsible for sales and service in the Midlands area.

Order for Electric Furnaces

It is learned that Hindustan Aircraft Limited, of Bangalore, India, have planned the manufacture of turbo-jet engines in collaboration with a British firm. **G.W.B. Furnaces Limited** and **Wild-Barfield Electric Furnaces Limited** have secured an order for the bulk of the many electric furnaces required for heat-treating the various Nimonic and aluminium alloy engine components.

Instrument Display

Shortly after opening the Zagreb International Trade Fair, Yugoslavia, this month, President Tito spent some time in the special Kelvin Hughes Mobile Demonstration Unit, which has been touring the Continent, and also displayed the company's products at the Fair.

This mobile unit has been making an extensive tour of East European countries, including Poland, Hungary and Czechoslovakia, and at the close of the Zagreb Fair was scheduled to visit Northern Italy and the Turin Instrumentation and Technical Exposition. Instruments on display in the unit include ultrasonic flaw detectors, high frequency recording boiler house and electro-medical equipment, and a 16 mm. Simplex-Ampro projector.

Colour Anodized Aluminium

In conjunction with the Building centre, the **Aluminium Development Association** is staging, at Store Street, London, W.C.1, for ten days from Wednesday next, October 1, an exhibition which will demonstrate the effects now available by the use of colour anodized aluminium for building exteriors.

It is expected that the examples will include curtain wall panels and spandrels, together with a full range of available colours, both on plain aluminium and on aluminium silicon alloy sheet. The exhibition is open to the public. On the opening day, at 5 p.m., three brief talks will be given on the subject of the exhibition and followed by informal discussion. The topics to be discussed will be as follows:—Characteristics of the finish acceptance specification, durability, erection and maintenance; fabrication and anodizing facilities, including colour range, now becoming available for dealing with large pieces, with indication of maximum sizes available; and suitable types of application, with description of existing installations, illustrated with projected colour transparencies.

Chiefly by the use of slides, the same three topics will be presented at lecture sessions on October 7 and 10, at 12.30 p.m.

Armenian Deposits

According to press reports from Moscow, Armenia's non-ferrous metal industry is being expanded. The most important mineral field under exploitation is the copper-molybdenum deposit at Kadzharan, in the southern part of Armenia. It has now been decided to start open-cast mining in that area, and this will make it possible to expand ore treatment plants and smelters located there.

Another copper-molybdenum deposit with the appropriate concentrating and refining facilities is being developed at Agarak, while a third such enterprise is being expanded at Dastakert. In addition to these comparatively new undertakings, the old lead-zinc and copper-zinc ore deposits at Kafan, Shampul and Akhtal are contributing heavily to the economy of the area.

Tasmanian Nickel Find

News from Canberra is that a rich nickel ore deposit has been discovered near Beconsfield, in Northern Tasmania, a Labour member for Tasmania has disclosed in the House of Representatives. The member, Mr. G. W. Duthie, appealed for Commonwealth aid to develop the field which, he said, was estimated to contain nickel worth A£22 million, and which could supply Australia for the next 40 years. It was the first nickel deposit discovered in Australia, and A£50,000 was all that was needed to develop it, Mr. Duthie claimed.

Showing in Birmingham

On Monday next, September 29, at the Midlands Electricity Board Industrial Showroom, 247 Chester Street, Aston, Birmingham, a private exhibition is to be opened by **Engelhard Industries Limited** (Baker Platinum Division and Hanovia Lamps Division) at 10 a.m. The exhibition will remain open until October 10.

A range of scientific and industrial equipment is to be shown, including the following:—the Hersch oxygen meter, an instrument designed for the continuous measurement of traces of molecular oxygen in other gases; the Deoxo catalytic gas purification processes; the "Dog Bone" shaped silver anodes; the autoset mercury vapour meter; the model 17 fluorescence lamp; and constant wattage ultra-violet light sources for industrial and scientific use.

Britain in Europe

This is the title of a 24-page pamphlet published by the Federal Educational and Research Trust in association with the Britain in Europe Committee. The pamplet is intended as a "simple-man's" guide to the Common Market and Free Trade Area proposal. It gives a clear and short summary leading up to the present negotiations, cutting through the economic jargon of many longer reports. It deals with some of the more common objections, including "What About Commonwealth Relations?" and the author sees the Free Trade Area as only one of the many challenges which every firm will have to meet, whatever happens.

Aluminium at Lloyd's

One of the features of Lloyd's new building in London is the extensive use that has been made of aluminium. Over 100 tons of alloy sections have been utilized, mainly for windows, but also for many decorative interior fittings. The new Underwriting Room is remarkable for its size, being about 340 ft. long by 120 ft. wide; including a gallery on all four sides, it provides a floor space of over 44,000 ft^2, more than twice the area previously available.

Natural lighting is provided by two roof lights and by a series of 23 large semi-circular-headed windows on the south, east and west frontages, some curved-on-plan and each approximately 30 ft. high by 15 ft. wide. In order to combine maximum light admission with a sufficiently strong framing to the windows, specially designed aluminium alloy extruded sections, which could be easily curved where required, were produced. These sections combined to form a glazing bar, 1½ in. wide and 4½ in. deep, of neat, simple appearance.

In addition to these feature windows, others of a normal rectangular type are also framed in aluminium. The glazing sections are similar to those used for the large windows, adopting the same principle of presenting identical faces on both

the inside and the outside of the glass, but as less strength is required, the depth of the main glazing member is reduced to 1⅞ in.

The anodized natural satin-silver finish of the metal produces, on the exterior, an effective contrast to the marble facings throughout the room, and the protective oxide coating (0·001 in. thick) will preserve the good appearance of all the windows on the exterior for many years, merely with regular cleaning, and so eliminate the need for periodic painting of the frames.

Aluminium alloy is also used for interior fittings, such as balustrades, louvres, door handles, beading, and many other items. All the aluminium is anodized to a satin-silver finish, and, to ensure colour matching, James Gibbons Limited, the metalworking specialists who made the fittings, used the same alloy throughout —HE10, supplied by **Northern Aluminium Company Limited.**

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week totalled 17,590 tons, comprising London 6,139, Liverpool 9,966, and Hull 1,485 tons. Copper stocks totalled 10,831 tons, and comprised London 5,549, Liverpool 5,007, Birmingham 75, Manchester 50, and Swansea 150 tons.

Indian Export Decision

According to news from Bombay, the Indian Government has announced that the export of mercury, nickel shots and ammonium sulphate will now be licensed for export "on merits."

U.S. Import Quotas

It was announced in New York on Monday last that the Government had imposed a lead-zinc quota equal to 80 per cent of average annual commercial imports of the two metals during 1953-57. This quota is to be effective as from October 1 next. It is understood that the unanimous recommendation of the members of the Tariff Commission to impose tariff duties on imports of the metals was turned down.

According to the figures recently issued by the American Bureau of Metal Statistics, the stocks of lead held in U.S. refineries at the end of July last totalled a record of 211,976 tons, more than double the figure at the commencement of this year.

Japanese Output

Statistics issued by the Ministry of International Trade and Industry in Tokyo show that output of electrolytic copper in August last recovered to 10,027 metric tons, but that production of zinc sharply decreased as the plan to curtail output by 20 per cent of normal production went into force on August 1.

Output figures for the two months August and July (in brackets) are given as follows: electrolytic copper 10,027 (9,762); lead 3,328 (3,235); electrolytic zinc 7,343 (9,474), and distilled zinc 3,927 (4,891), all in metric tons.

Austrian Statistics

Recent figures issued in Vienna show that Austria's primary aluminium output amounted to 32,190 metric tons in the first half of the current year, about 11 per cent down on the comparable period a year earlier, while production of aluminium semis also declined, by about 11·6 per cent, to 11,838 metric tons.

Electrolytic copper output was down on the period by about 2·5 per cent to 4,631 tons, but that of secondary metal advanced to 1,061 tons from 848 tons. Semis of copper and copper alloys amounted to 15,624 tons—an advance of 26·7 per cent on the period. Production of hard lead rose by some 260 tons to 1,169 tons, while that of soft lead was 4,558 tons—practically unchanged from the figures of a year before. Output of electrolytic zinc advanced by 14 per cent to 5,200 tons.

Birlec and Efco

It has been announced by **Birlec Limited** and **Efco Limited** that negotiations between them for the formation of a new company to take over certain sections of their business, have reached an advanced stage. It is intended that the new company shall be called **Birlec-Efco (Melting) Ltd.,** and that its offices shall be near Birmingham, at Aldridge, Staffs.

The intended scope of the new company is the design and supply of all types of electric melting furnaces for the ferrous and non-ferrous metals industries, together with smelting furnaces and induction heating equipment.

The personnel of the company will be drawn from the appropriate divisions of the Birlec and Efco companies, thus combining in one organization the specialist techniques and extensive experience of both companies. Both companies will continue independently to manufacture their respective heat-treatment furnaces and other plant.

A Jubilee Cruise

Readers may remember that in last week's issue of this journal (page 240) we made reference to the diamond jubilee celebrations of **John Allan and Co. (Glenpark) Ltd.** Part of the celebrations consisted of a day's cruise on the Firth of Clyde, and in this connection it is interesting to note that among those who attended the cruise were the following:— Mr. John Black, vice-chairman of Metal Industries Ltd. and a director of John Allan; Mr. J. E. Stevenson, managing director of John Allan; Mr. R. F. Maclean, Mr. H. H. Bieyer, and Mr. D. Reid, all directors of John Allan; Sir William Garrett, a director of Metal Industries Ltd. and President of the British Employers' Federation; Mr. John Knowles, director of Metal Industries Ltd. and chairman of B.E.A.M.A.; Mr. M. Wilkinson, managing director of Shipbreaking Industries and director of Metal Industries (Salvage) Ltd.; also local representatives of associated companies, Brockhurst Switchgear and Igranic Industries, with other specially invited guests. Sir Charles Westlake, chairman of Metal Industries Ltd., and Mr. John Allan were on the quay to see the start of the cruise.

Metric System for Japan

It is understood that, as from January 1 next, the use of the metric system will be compulsory for almost all purposes in Japan. The laws enforcing this do not apply to foreign trade, and exporters to Japan may continue to invoice or make quotations on the basis of weights and measures common to international trade.

It is pointed out, however, that exporters may find it convenient to their customers to use the metric system, as wholesalers or retailers will be obliged to apply metric measurements once goods have passed the Japanese customs.

Change of Name

Supplier of liquefied petroleum gases, the firm of Bottogas Limited is changing its name to **Shell-Mex and B.P. Gases Ltd.** The new name reflects the closer integration which is taking place with the company's parent group, although products will continue to be marketed under the brand name of "Bottogas."

The gases propane and butane, supplied by the company, are being used increasingly in industry for such purposes as firing metallurgic furnaces, the production of protective atmospheres for gas carburizing and carbo-nitriding processes, bright annealing and the enrichment of producer gas. The registered office of the company remains at Cecil Chambers, 76-86 Strand, London, W.C.2.

Electric Hoist

The recently introduced Matterson one-ton 101 electric hoist has now been supplemented by a half-ton model. It is available for maximum light heights of 23 ft. and 43 ft., as a runway hoist or for fixed suspension. A low headroom hoist is available, enabling the hook to lift within 13 in. of the runway beam. Push, hand geared or electric travel can be provided.

Oil Burning Equipment

It has been announced by **Stordy Engineering Ltd.** that they are now able to provide to industry the complete range of the genuine "Hauck" designed fully-proportioning oil burner, together with the special ancillary equipment which has been developed by the Hauck Organization of America.

The complete range of Hauck combustion equipment includes the following: micro cam oil valve; self-clean metering oil valve; proportioning oil burner; combination proportioning oil and gas burners; radiant tube burners (for either oil or gas) and radiant tube gas burners.

A Golf Meeting

On Monday last, at the Blackwell Golf Club, the **Metal Finishing Association** held a golf meeting and a competition for a silver rose bowl which had been presented to the association by Mr. F. W. Bulpitt, of Metal Finishes Limited.

The competition was played under the Stapleford rules, and was won by Mr. R. G. Hughes (Electro Chemical Engineering Co. Ltd.) with 43 points; second was Mr. A. G. Shorthouse (W. Canning and Co. Ltd.) with 40 points, and Mr. F. W. Bulpitt was third with 30 points.

Vacuum Fusion Gas Analyser

An announcement has been made by **Wild-Barfield Electric Furnaces Ltd.** to the effect that the NRC type 912 vacuum fusion gas analyser, for the determination of oxygen, nitrogen and hydrogen in metals, is now available as a British-built unit. Over two hundred of these equipments are stated to be in operation, and it is of interest to note that, because of the ability of type 912 to analyse very small samples, only a 3·5 kW induction heating generator is employed.

A demonstration equipment has been installed at Elecfurn Works, Watford, where, by prior appointment, prospective customers may witness a complete analysis.

Fuel Efficiency

Among the many types of equipment, plant and machinery which are being exhibited at the **Industrial Fuel Efficiency Exhibition,** which opened at Olympia, London, on Wednesday last (September 24) are included the following items, which have been notified to us by firms participating in this exhibition.

A wide range of liquid fuel improvers and combustion additives is being shown by **The Amber Chemical Co. Ltd.,** and of special interest to users of all types of diesel engines, Amber SSR 513 diesel oil treatment is particularly featured for the first time. This company's display also includes the latest Amber patented injection system as supplied to major industrial installations and power stations.

The important part which electricity plays both in the fields of fuel economy and productivity will be seen on the stand of the **Electrical Development Association.** Industrial applications of electricity forming the exhibit will range from a high sensitivity thickness gauge, an electronic smoke density meter for indicating when a factory chimney is emitting black smoke, a battery electric truck for works use, an electrically lighted bottle inspection device, a layout illustrating induction heating and quenching being carried out in the production line, to an example of a crucible furnace for process heating.

A large animated panel on the stand of **The Gas Council** shows how tank heating can be made faster and cheaper. This panel will contrast efficient and inefficient methods of insulating, lagging, and heating generally. The panel will be supported by pictorial displays which will show "case histories" of old and new ways of using heat economically. There are also four large transparencies which will show industrial installations where gas is used on a large scale. A new type of coke stoker for firing steam-raising boilers is also exhibited. This stoker, manufactured by Joshua Bigwood and Son Ltd., has been examined and tested by the coke technical department of the Gas Council.

Various types of plant are shown on the stand of **W. C. Holmes and Co. Ltd.,** including a catalytic sulphur removal plant, the Holmes-Schneible multi-wash system, which is applicable to a wide range of dust collection and control problems involving liquid and solid particles, the Holmes-Rothemuhle multi-cell cyclone dust collector, designed to reduce the stack emissions from hand, stoker and pulverized fuel-fire boilers, the Trion electronic air filter, and the Holmes-Connersville positive air blowers.

Controls for all stages in the production and distribution of heat are displayed by **Honeywell Controls Ltd.,** and these include an indicating furnace pressure controller, a multiple point electronic temperature recorder, an electronic temperature indicator, and non-indicating temperature and pressure controllers. The latest electronic controls for combustion programme and safety applications are also displayed. Space heating control systems show how the delivery of heat can be controlled precisely and with maximum economy.

The theme of the stand of **Keith Blackman Ltd.** is that of fuel efficiency and clean air, both of which are so closely associated with fan engineering equipment and/or industrial gas apparatus. Among the exhibits displayed by the company are the following:—(1) Two high pressure blowers for supplying air blast for combustion to oil and gas-fired furnaces; (2) a high temperature bifurcated-type axial fan for recirculating hot air or other gases; (3) a steam heated unit heater for space heating purposes in factories, workshops, and public buildings; (4) a selection of industrial gas apparatus, including an air or gas compressor for supplying pressures up to 5 lb/in^2, a Type 3 mixture controller for the accurate control of air/gas mixture ratios, burner nozzles, injectors, and a thermostat complete with relay governor; (5) a working model of the Keith Blackman-Broman Ekstrom shot cleaning system, which ensures maximum heat transfer in heat exchangers; (6) a model of the Cupodel hot blast cupola plant, which provides improved combustion conditions in cupolas; (7) a 10 in. size induced draught and grit arresting fan, which not only provides the required boiler draught but reduces to a minimum the discharge of dust particles to atmosphere; (8) a Type AR aerofoil section, backward bladed impeller of the high efficiency type, widely used for induced draught; and (9) a model of a PD-KB multitubular dust collector, used for the removal of fly ash from flue gases of power stations and medium size industrial boilers; also the recovery of dust removed from foundries, and the recovery of valuable dust from crushing and grinding plant and associated conveyors.

An interesting range of castable and mouldable refractories is displayed by **Morgan Refractories Ltd.** In this company's "Tri-Mor" range are the high temperature mouldable, the high strength castable, the insulating castable, and the high temperature castable refractories. With these, the company states, it is possible to obtain the advantages of monolithic construction (in freedom of design, efficiency and shape), combined with a performance of inestimable value to all industries which use a furnace, oven or kiln. Refractories for special purposes are also on show in four sections and a selection of ancillary "Triangle" recrystallized alumina ware for use in laboratories at high temperatures up to 1,950°C. where material of a very pure nature is required.

Exhibits are also being made by **G.W.B. Furnaces Limited** and **Wild-Barfield Electric Furnaces Limited.**

Forthcoming Meetings

September 30 — Institute of British Foundrymen. Slough Section. Lecture Theatre, High Duty Alloys Limited, Slough. "Precision-Casting Techniques": a "Brains Trust," with P. Gainsbury, D. Chapman and A. Dunlop on the panel. 7.30 p.m.

October 1—Society of Chemical Industry. Corrosion Group. Society of Chemical Industry, 14 Belgrave Square, London, S.W.1. "Corrosion Embrittlement: The Effect of Cathodically Evolved Hydrogen on Iron and Nickel." M. Smialowski. 6.30 p.m.

October 3—Society of Instrument Technology. Fawley Section. Copthorne House, Fawley, Hants. "The Evaluation of Instruments for Chemical Processes." D. M. Bishop. 7 p.m.

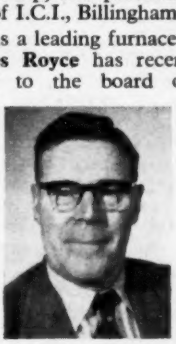
Men and Metals

Chairman of Imperial Chemical Industries Limited, **Sir Alexander Fleck** has been appointed chairman of the Minister of Power's Scientific Advisory Council. Sir Alexander is also this year's President of the British Association for the Advancement of Science.

Director of the British Welding Research Association, **Dr. Richard Weck,** Ph.D., A.M.I.C.E., A.M.I.Mech.E., has accepted an invitation from the American Society for Metals to lecture to its Seminar on Residual Stresses, at the end of next month, at Cleveland, Ohio, during the national congress of the society. Dr. Weck has been chairman of the International Institute of Welding's Commission on Residual Stresses since 1948.

Board changes announced recently by George Kent Ltd., are as follows: **Mr. R. E. Handford,** B.Sc., deputy managing director, relinquishes his executive functions but retains his seat on the board. He has been in the company's service for 45 years. **Mr. W. A. Hartop** has been appointed managing director, and **Cmdr. P. W. Kent,** formerly chairman and managing director, continues as chairman. At the end of this month two directors will retire: **Mr. W. Guy Ardley** and **Mr. Leslie H. Kent,** A.M.I.C.E., M.I.Mech.E. **Mr. T. P. W. Norris** has been appointed a director. He was lately chief personnel officer of the Vickers Group, and previously labour manager of I.C.I., Billingham Division.

Noted as a leading furnace designer, **Mr. James Royce** has recently been appointed to the board of Hedin



Limited, the industrial electrical heating equipment specialists, of South Woodford, London, E.18.

Executive director in charge of export sales for Simmonds Aerocessories Limited and Firth Cleveland Instruments Limited, **Mr. A. P. H. Pehrson** is making a sales visit to Italy and France during this month. The assistant export sales manager of Simmonds Aerocessories Ltd., **Mr. W. H. Dothie,** is visiting the company's agents in Ireland, and afterwards will go on to Germany and Austria.

News from Sheepbridge Equipment Limited is to the effect that **Mr. J. S. Wood** has been appointed a representative of the Sand Foundry Division. He will be responsible for the Midlands area of the company.

Metal Market News

LAST week saw the publication of copper statistics by the American Copper Institute for the month of August, and it is not too much to say that they created an excellent impression. Indeed, after studying the figures as presented for the United States, current comment in metal circles is that there certainly seemed no reason at all why the U.S. Government should have contemplated stockpiling 150,000 tons. Details, in short tons of 2,000 lb., are as follow: production of crude copper was 76,492 tons, against 73,302 tons in July, while the output of refined metal was 100,640 tons, compared with 110,130. Deliveries of refined copper to consumers advanced by nearly 9,500 tons to 86,982, while stocks in producers' hands, at 215,560 tons, compared with 242,781 tons a month earlier. Outside the United States the output of refined copper amounted to 117,274 tons, against 119,448 tons in July, while production of crude at 157,282 showed an increase of 4,753 tons on the previous month. Deliveries were a bright spot at 160,078 tons, for this showed an increase of 16,800 tons. Stocks of refined copper, at 220,972 tons, compared with 232,383 tons at July 31. Figures issued by the British Bureau of Non-Ferrous Metal Statistics give the July copper consumption in the U.K. at 53,564 tons, a drop of nearly 4,000 tons on June, which was, of course, an exceptionally good month. Stocks advanced by nearly 3,000 tons to 84,756 tons. In lead, consumption was about 1,400 tons down at 27,201 tons, while stocks of refined pig dropped by 3,370 tons to 37,148 tons. Zinc followed a similar pattern, stocks declining from 49,613 tons to 48,497 tons at July 31. Consumption was 17,420 tons, against 19,054 tons. Consumption of tin was 1,656 tons, 63 tons down.

Markets were very active last week, with turnovers above the average, but naturally interest centred, at any rate during the second half of the week, on the startling and unprecedented events in tin. The bombshell, in the shape of an announcement that the Tin Council was no longer supporting the metal at £730, was dropped during the second ring on Thursday, and dealings were suspended. In the afternoon, dealing began again and at the close cash was £645 and three months £642 10s. 0d. Friday saw a recovery to £680 cash and £670 three months by the end of the afternoon session. The turnover was 1,235 tons, and on balance cash lost £50 10s. 0d. and forward £60. The outlook is now obscure, but following the next meeting of the Tin Council it may be supposed that a statement will be issued. It is estimated that the Tin Council is now holding about 25,000 tons of tin. Popular opinion seems to be that support of the tin market ceased because funds were exhausted, but this idea may be incorrect for it is, of course, possible that the withdrawal from the tin ring may be for policy reasons. Left to find its own level, the market may be all the healthier in consequence, and in some directions sentiment is not so bearish. At the beginning of last week stocks of tin were 36 tons up at 17,188 tons.

The turnover in copper last week was heavy at about 13,000 tons, including Kerb dealing, and both positions closed £4 15s. 0d. higher on balance at £212 and £212 5s. 0d. respectively. Stocks declined 100 tons to 10,931 tons. In the States, two advances by the custom smelters, each of one-eighth of a cent, took their quotation up to 26½ cents, in line with the producers' price. Business with Continental users and Iron Curtain countries was reported. On Thursday, £213 10s. 0d. was reached, but the market fell away on Friday and closed below the best. Although the U.S. lead price went up to 11 cents in midweek, both zinc and lead were rather depressed in view of the announcement that the United States was likely to adopt an import quota system for these two metals. Both closed above the lowest, and higher on balance than the previous Friday, September lead by 25s. and December by 15s., while zinc was 12s. 6d. and 15s. better for the respective positions.

Birmingham

The downward trend in industrial production, particularly in the basic industries, was referred to at the recent meeting of the Midland Regional Board for Industry. It was stated that the gradual increase in unemployment, particularly in iron and steel and non-ferrous foundries, was continuing, but the Midlands region was still in a better position than the country as a whole. The Board was told that as a result of the visit of the Canadian trade mission last year, a keener interest is being taken in the Canadian market. There has been a 50 per cent increase in the number of requests to the Board of Trade to find agents for Midland exporters. The motor trade, however, is moving against the general trend and presents an encouraging picture.

Sheets used in the motor trade are in good demand, and there is still an active market for heavy plates, although pressure is much less than some months ago and delivery can be given earlier. Although the number of blast furnaces working has been reduced, the supply of pig iron is ample for all requirements. The most active demand is for iron for the production of heavy castings for the engineering industries. It is thought that some steel users are holding off the market in the hope of lower prices, but any easing seems unlikely having regard to costs of production, and especially the high price of coke. There is a good market for steel to be used by manufacturers of heavy electrical equipment.

New York

In physical metals, copper and tin firmed, while lead and zinc held at unchanged prices during the past week. Except for some evening-up, the futures prices of all metals traded on the Commodity Exchange finished at the week's best. In copper, the Northern Rhodesian labour strike, which reportedly halted shipments of blister copper to the U.S., was said to be the primary factor responsible for a ⅛ cent per lb. increase in the custom smelter price of refined copper. Custom smelters' copper offerings at the new 26⅝ cents price were described as spotty, with some smelters reluctant to sell in anticipation of still higher prices. Consumer demand was described as good in copper at all levels. Producers continued to adhere to their 26½ cents for refined copper.

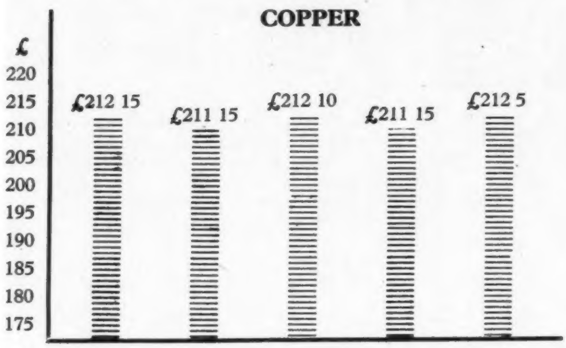
Scrap copper appeared to be offered sparingly with the market's undertone firm, dealers said. Copper also reflected the possibility of a labour strike at the International Nickel Company's Copper Cliff and Port Colborne refineries. Copper prices within Canada for internal consumption stiffened, reflecting better demand and a recently lower premium on the Canadian dollar.

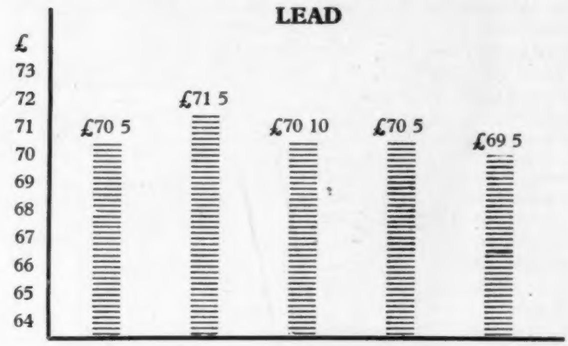
In lead and zinc, traders watched developments in the automobile industry labour situation. The trade also studied the recommendations by the United Nations conference which concluded a three-day meeting last Saturday in London. Some quarters here expressed the belief that it might take a long time to have the United Nations recommendations implemented, and that the entire question on aid to the domestic mining industry might have to revert to the White House. Lead and zinc traders also watched the continued long-shore dispute at British Columbia ports.

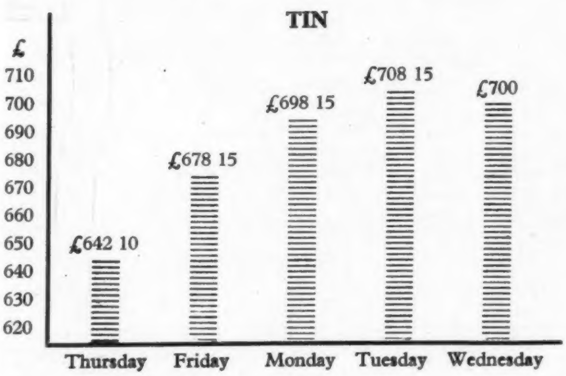
Lead met with good demand at 10¾ cents per lb. New York and, at the current rate of sales, it appears likely that producers will be able to dispose of all of their September domestic intake. Zinc found a generally good consumer reception basis, Prime Western at 10 cents per lb. East St. Louis, but demand from the brass industry was disappointing.

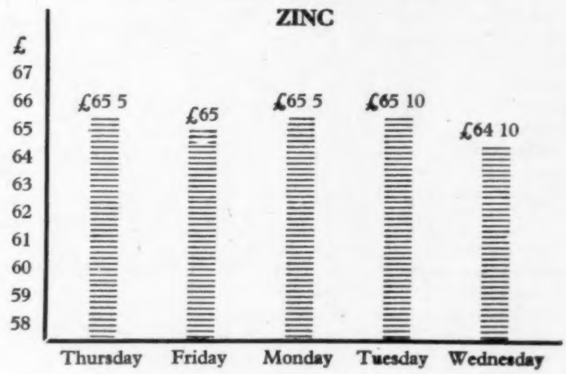
METAL PRICE CHANGES

LONDON METAL EXCHANGE, Thursday 18 September 1958 to Wednesday 24 September 1958









OVERSEAS PRICES

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

	Belgium fr/kg ≏ £/ton		Canada c/lb ≏ £/ton		France fr/kg ≏ £/ton		Italy lire/kg ≏ £/ton		Switzerland fr/kg ≏ £/ton		United States c/lb ≏ £/ton	
Aluminium			22.50	185 17 6	210	182 15	375	217 10			26.80	214 10
Antimony 99.0					195	169 12 6	420	243 12 6			29.00	232 0
Cadmium					1,500	1,305 0					155.00	1,240 0
Copper												
Crude												
Wire bars 99.9							425	246 10				
Electrolytic	29.50	215 12 6	25.75	212 12 6	263	228 17 6			2.67	223 5	26.50	212 0
Lead			10.50	86 15	110	95 15	177	101 10	.89	76 10	11.00	88 0
Magnesium												
Nickel			70.00	578 5	1,205	1,048 7 6	1,300	754 0	7.56	632 2 6	74.00	592 0
Tin	99.50	737 7 6					1,420	823 12	8.60	719 2 6	90.50	724 0
Zinc												
Prime western			10.00	82 12 6							10.00	80 0
High grade 99.95			10.60	87 10 0								
High grade 99.99			11.00	90 5								
Thermic					107.12	93 2 6						
Electrolytic					115.12	100 2 6	161	93 7 6	.88	73 10	11.25	90 0

NON-FERROUS METAL PRICES

(All prices quoted are those available at 12 noon 24/9/58)

PRIMARY METALS

		£	s.	d.
Aluminium Ingots	ton	180	0	0
Antimony 99·6%	„	197	0	0
Antimony Metal 99%	„	190	0	0
Antimony Oxide	„	180	0	0
Antimony Sulphide Lump	„	190	0	0
Antimony Sulphide Black Powder	„	205	0	0
Arsenic	„	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	„		9	6
Calcium	„	2	0	0
Cerium 99%	„	16	0	0
Chromium	„		6	11
Cobalt	„		16	0
Columbite .... per unit			—	
Copper H.C. Electro.	ton	212	5	0
Fire Refined 99·70%	„	211	0	0
Fire Refined 99·50%	„	210	0	0
Copper Sulphate	„	72	10	0
Germanium	grm.		—	
Gold	oz.	12	10	2
Indium	„		10	0
Iridium	„	20	0	0
Lanthanum	grm.		15	0
Lead English	ton	69	5	0
Magnesium Ingots	lb.		2	5½
Notched Bar	„		2	10½
Powder Grade 4	„		6	3
Alloy Ingot, A8 or AZ91	„		2	8
Manganese Metal	ton	290	0	0
Mercury	flask	79	0	0
Molybdenum	lb.	1	10	0
Nickel	ton	600	0	0
F. Shot	lb.		5	5
F. Ingot	„		5	6
Osmium	oz.		nom.	
Osmiridium	„		nom.	
Palladium	„	5	15	0
Platinum	„	21	5	0
Rhodium	„	40	0	0
Ruthenium	„	15	0	0
Selenium	lb.		nom.	
Silicon 98%	ton		nom.	
Silver Spot Bars	oz.		6	4⅛
Tellurium	lb.		15	0
Tin	ton	700	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	„		—	
Virgin Min 98%	„	64	11	10½
Dust 95/97%	„	104	0	0
Dust 98/99%	„	110	0	0
Granulated 99+%	„	89	11	10½
Granulated 99·99+%	„	102	7	6

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

Aluminium Alloy (Virgin)		£	s.	d.
B.S. 1490 L.M.5	ton	210	0	0
B.S. 1490 L.M.6	„	202	0	0
B.S. 1490 L.M.7	„	216	0	0
B.S. 1490 L.M.8	„	203	0	0
B.S. 1490 L.M.9	„	203	0	0
B.S. 1490 L.M.10	„	221	0	0
B.S. 1490 L.M.11	„	215	0	0
B.S. 1490 L.M.12	„	223	0	0
B.S. 1490 L.M.13	„	216	0	0
B.S. 1490 L.M.14	„	224	0	0
B.S. 1490 L.M.15	„	210	0	0
B.S. 1490 L.M.16	„	206	0	0
B.S. 1490 L.M.18	„	203	0	0
B.S. 1490 L.M.22	„	210	0	0

		£	s.	d.
†Aluminium Alloy (Secondary)				
B.S. 1490 L.M.1	ton	146	0	0
B.S. 1490 L.M.2	„	153	0	0
B.S. 1490 L.M.4	„	170	10	0
B.S. 1490 L.M.6	„	188	10	0

†Average selling prices for mid August

		£	s.	d.
***Aluminium Bronze**				
BSS 1400 AB.1	ton	207	0	0
BSS 1400 AB.2	„		—	
***Brass**				
BSS 1400-B3 65/35	„	140	0	0
BSS 249	„		—	
BSS 1400-B6 85/15	„		—	
***Gunmetal**				
R.C.H. 3/4% ton	ton		—	
(85/5/5/5)	„	174	0	0
(86/7/5/2)	„	186	0	0
(88/10/2/1)	„	232	0	0
(88/10/2/½)	„	242	0	0
Manganese Bronze				
BSS 1400 HTB1	„	173	0	0
BSS 1400 HTB2	„	180	0	0
BSS 1400 HTB3	„		—	
Nickel Silver				
Casting Quality 12%	„		nom.	
„ „ 16%	„		nom.	
„ „ 18%	„		nom.	
***Phosphor Bronze**				
2B8 guaranteed A.I.D. released	„	262	0	0
Phosphor Copper				
10%	„	230	0	0
15%	„	235	0	0

**Average prices for the last week-end.*

		£	s.	d.
Phosphor Tin				
5%	ton		—	
Silicon Bronze				
BSS 1400-SB1	„		—	
Solder, soft, BSS 219				
Grade C Tinmans	„	328	6	0
Grade D Plumbers	„	266	3	0
Grade M	„	359	6	0
Solder, Brazing, BSS 1845				
Type 8 (Granulated)	lb.		—	
Type 9 „	„		—	
Zinc Alloys				
Mazak III	ton	95	12	6
Mazak V	„	99	12	6
Kayem	„	105	12	6
Kayem II	„	111	12	6
Sodium-Zinc	lb.		2	5

SEMI-FABRICATED PRODUCTS

Prices of all semi-fabricated products vary according to dimensions and quantities. The following are the basis prices for certain specific products.

Aluminium		£	s.	d.
Sheet 10 S.W.G.	lb.		2	8
Sheet 18 S.W.G.	„		2	10
Sheet 24 S.W.G.	„		3	1
Strip 10 S.W.G.	„		2	8
Strip 18 S.W.G.	„		2	9
Strip 24 S.W.G.	„		2	10¼
Circles 22 S.W.G.	„		3	2
Circles 18 S.W.G.	„		3	1
Circles 12 S.W.G.	„		3	0
Plate as rolled	„		2	7¼
Sections	„		3	1¼
Wire 10 S.W.G.	„		2	11
Tubes 1 in. o.d. 16 S.W.G.	„		4	0

		£	s.	d.
Aluminium Alloys				
BS1470. HS10W.	lb.			
Sheet 10 S.W.G.	„		3	0½
Sheet 18 S.W.G.	„		3	3
Sheet 24 S.W.G.	„		3	10½
Strip 10 S.W.G.	„		3	0½
Strip 18 S.W.G.	„		3	2
Strip 24 S.W.G.	„		3	10
BS1477 HP30M.				
Plate as rolled	„		2	10¼
BS1470. HC15WP.				
Sheet 10 S.W.G.	lb.		3	6½
Sheet 18 S.W.G.	„		4	0½
Sheet 24 S.W.G.	„		4	10½
Strip 10 S.W.G.	„		3	9½
Strip 18 S.W.G.	„		4	0½
Strip 24 S.W.G.	„		4	8
BS1477. HPC15WP.				
Plate heat treated	„		3	5½
BS1475. HG10W.				
Wire 10 S.W.G.	„		3	9½
BS1471. HT10WP.				
Tubes 1 in. o.d. 16 S.W.G.	„		4	11
BS1476. HE10WP.				
Sections	„		3	1
Beryllium Copper				
Strip	„	1	4	11
Rod	„	1	1	6
Wire	„	1	4	9
Brass Tubes	„		1	7⅞
Brazed Tubes	„		—	
Drawn Strip Sections	„		—	
Sheet	ton		—	
Strip	„	231	5	0
Extruded Bar	lb.		1	10⅜
Extruded Bar (Pure Metal Basis)	„		—	
Condenser Plate (Yellow Metal)	ton	168	0	0
Condenser Plate (Naval Brass)	„	179	0	0
Wire	lb.		2	5⅝
Copper Tubes	lb.		2	0½
Sheet	ton	242	5	0
Strip	„	242	5	0
Plain Plates	„		—	
Locomotive Rods	„		—	
H.C. Wire	„	262	5	0
Cupro Nickel				
Tubes 70/30	lb.		3	4⅞
Lead Pipes (London)	ton	110	0	0
Sheets (London)	„	107	15	0
Tellurium Lead	„	£6 extra		
Nickel Silver				
Sheet and Strip 7%	„		3	5¼
Wire 10%	„		3	11¼
Phosphor Bronze				
Wire	„		3	9¾

Titanium (1,000 lb. lots)			
Billet over 4" dia.-18" dia.	lb.	63/-	64/-
Rod 4" dia. - ·250" dia.	„	75/-	112/-
Wire under ·250" diam. - ·036" diam.	„	146/-	222/-
Sheet 8'×2'×·250"-·010" thick	„	88/-	157/-
Strip ·048"-·003" thick	„	100/-	350/-
Tube (representative gauge)	„		300/-
Extrusions	„		120/-

		£	s.	d.
Zinc Sheets, English destinations	ton	99	10	0
Strip	„		nom.	

Scrap Metal Prices

Merchants' average buying prices delivered, per ton, 23/9/58.

	£
Aluminium	
New Cuttings	134
Old Rolled	110
Segregated Turnings	90
Brass	
Cuttings	128
Rod Ends	124
Heavy Yellow	108
Light	103
Rolled	120
Collected Scrap	104
Turnings	118
Copper	
Wire	178
Firebox, cut up	175
Heavy	169
Light	164
Cuttings	178
Turnings	160
Braziery	140

	£
Gunmetal	
Gear Wheels	168
Admiralty	168
Commercial	143
Turnings	138
Lead	
Scrap	62
Nickel	
Cuttings	—
Anodes	450
Phosphor Bronze	
Scrap	143
Turnings	138
Zinc	
Remelted	55
Cuttings	42
Old Zinc	30

The latest available scrap prices quoted on foreign markets are as follow. (The figures in brackets give the English equivalents in £1 per ton):—

West Germany (D-marks per 100 kilos):		
Used copper wire	(£181.0.0)	208
Heavy copper	(£174.0.0)	200
Light copper	(£148.0.0)	170
Heavy brass	(£111.7.6)	128
Light brass	(£87.0.0)	100
Soft lead scrap	(£61.0.0)	70
Zinc scrap	(£34.17.6)	40
Used aluminium unsorted	(£87.0.0)	100
France (francs per kilo):		
Copper	(£208.17.6)	240
Heavy copper	(£208.17.6)	240
Light brass	(£143.10.0)	165
Zinc castings	(£65.5.0)	75
Lead	(£82.12.6)	95
Tin	(£565.10.0)	650
Aluminium	(£117.10.0)	135

Italy (lire per kilo):		
Aluminium soft sheet clippings (new)	(£191.10.0)	330
Aluminium copper alloy	(£119.0.0)	205
Lead, soft, first quality	(£84.12.6)	146
Lead, battery plates	(£49.17.6)	86
Copper, first grade	(£194.7.6)	335
Copper, second grade	(£179.17.6)	310
Bronze, first quality machinery	(£188.10.0)	325
Bronze, commercial gunmetal	(£159.10.0)	275
Brass, heavy	(£130.10.0)	225
Brass, light	(£119.0.0)	205
Brass, bar turnings	(£127.12.6)	220
New zinc sheet clippings	(£55.2.6)	95
Old zinc	(£40.12.6)	70

Financial News

Thos. Bolton and Sons

An interim dividend of 2½ per cent for 1958 has been declared by the directors, who state that extremely competitive conditions continue to be experienced in the copper sulphate industry. Present indications, the directors say, are that the results for the full year will be lower than those of last year.

Expanded Metal Company

Declaring an interim dividend of 6 per cent for 1958 on a capital increased by a one-for-four scrip issue, the directors of this company propose a further 25 per cent free issue. It is also proposed to increase the authorized capital from £575,000 to £1 million. An extraordinary meeting is to be called when amendments to the articles are to be considered.

Vickers Ltd.

For the first six months of this year an interim dividend of 2½ per cent (same) is being declared by the company on a capital increased to £41 million by a two-for-five rights issue. Last year's final dividend of 7½ per cent was on the increased capital. In a statement for the half-year, made by the chairman, Lord Knollys, he says that 1958 profits will almost certainly not come up to last year's level.

Hudson and Wright Ltd.

It has been reported that Yorkshire Imperial Metals Ltd. has offered 6s. 9d. cash for each of the 2,210,000 Ordinary 2s. shares of the Birmingham company, Hudson and Wright Ltd. It is understood that the offer is subject to a 90 per cent acceptance, or such lesser percentage as the Yorkshire concern may agree to accept.

An Acquisition

It has been announced by Sir Charles Westlake, chairman of Metal Industries Limited, in a letter to stockholders, that his group has acquired the whole of the share capital of the privately-owned Towler Brothers (Patents) Limited, and its wholly-owned subsidiary, Electraulic Presses Limited. The purchase price is £800,000, payable in cash.

With a modern factory at Rodley, near Leeds, Towlers is looked upon as one of the country's leading manufacturers of hydraulic pumps and hydraulic control systems. Profits of the business have risen from £44,000 (before tax) in 1952 to an estimated £140,000 (before tax) in the year to September 30, 1958.

Trade Publications

Turret Punch Press.—Dowding and Doll Ltd., 346 Kensington High Street, London, W.14.

Particulars of a new model British Wiedemann turret punch press—the R.61—are given in a new leaflet published by this company. This new model is a heavy-duty press of 80,000 lb. punching pressure. The turrets are rotated by a geared ½ h.p. motor controlled from the operating position. They can be supplied with 20, 24 or 28 stations. Rotation of the turrets is synchronized and the tools in the working position are positively located with the punch and die in perfect alignment. The press is electrically tripped and cannot be operated between stations.

Hydraulic Equipment.—E. P. Barrus (Concessionaires) Ltd., 12-16 Brunel Road, Acton, London, W.3.

A new catalogue issued by this company contains full details of the new push-pull Holl-O-Ram hydraulic units and push-pullers, including a comprehensive table of specifications, and also covers the entire range of Blackhawk hydraulic Porto-Power equipment.

Dust Filters.—Dallow Lambert and Co. Ltd., Thurmaston, Leicester.

A four-page leaflet produced by this company deals with their Drytube dust filters, which form one of the company's comprehensive range of wet and dry collectors. There are a number of useful photographs accompanying the details.

Melting Metals.—W. J. Hooker Ltd., 239a Finchley Road, London, N.W.3.

A coloured four-page leaflet here describes the Radyne Hookercaster, which is designed to melt all metals from light alloys to gold and silver, and through the range of non-ferrous metals up to steel and platinum. The combination of the melting unit with the centrifugal casting unit ensures that the cast is made within seconds of the metal reaching the right temperature, and without any need to remove the crucible. The casting is thus made under optimum conditions, not only quickly but cleanly and economically, reproducing fine detail with precision and giving excellent physical properties. The leaflet gives all these details, with useful data and illustrations.

Press Brake Tool Manual. — The Bronx Engineering Co. Ltd., Lye, near Stourbridge, Worcs.

This tooling manual of some 70 pages is intended to assist all press brake users by surveying the many types of tools which can be used on the Bronx press brake machines, and also to act as a guide in the best choice of tools. The subject has been well dealt with from the viewpoints of both new operators as well as from that of experienced designers, by giving information and examples, both elementary and advanced, in the belief that what is needful to the one may be useful to the other. This manual certainly achieves its object, for its pages are designed for easy reference (it is in loose-leaf binding), it is illustrated by many diagrams and photographs, and, in addition to general details, considerable data and tabular matter are given. It is stressed that tool problems which may not be dealt with in this brochure can be referred to the company's press brake tool service at their headquarters.

THE STOCK EXCHANGE

After Considerable Buoyancy Prices Inclined To React In Quieter Conditions

ISSUED CAPITAL ●	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 23 SEPTEMBER	+RISE —FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1958 HIGH	1958 LOW	1957 HIGH	1957 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	21/9	+1½d.	9	10	8 5 6	21/9	17/6	28/3	18/–
400,000	2/–	Anti-Attrition Metal	1/6		4	8½	5 6 9	1/6	1/3	2/6	1/6
33,639,483	Stk. (£1)	Associated Electrical Industries ...	53/–	—9d.	15	15	5 13 3	53/9	46/6	72/3	47/9
1,590,000	1	Birfield Industries	59/6	+1/6	15	15	5 0 9	59/6	46/3	70/–	48/9
3,196,667	1	Birmid Industries	74/–	—9d.	17½	17½	4 14 6	76/3	55/3	80/6	55/9
5,630,344	Stk. (£1)	Birmingham Small Arms	31/3	—3d.	10	8	6 8 0	32/3	23/9	33/–	21/9
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	16/1½	+7½d.	5	5	6 4 0	16/1½	14/7½	16/–	15/–
350,580	Stk. (£1)	Ditto Cum. B. Pref. 6%	17/4½	+1½d.	6	6	6 18 3	17/4½	16/6	19/–	16/6
500,000	1	Bolton (Thos.) & Sons	26/3	+1/3	12½	12½	9 10 6	28/9	24/–	30/3	28/9
300,000	1	Ditto Pref. 5%	15/–xd	—1½d.	5	5	6 13 3	16/–	15/–	16/9	14/3
160,000	1	Booth (James) & Co. Cum. Pref. 7%	20/–		7	7	7 0 0	19/4½	19/–	22/3	18/9
9,000,000	Stk. (£1)	British Aluminium Co.	50/9	—4/–	12	12	4 14 6	54/9	36/6	72/–	38/3
1,500,000	Stk. (£1)	Ditto Pref. 6%	19/3		6	6	6 4 9	19/3	18/4½	21/6	18/–
15,000,000	Stk. (£1)	British Insulated Callender's Cables	45/6	+1/–	12½	12½	5 10 0	46/–	38/9	55/–	40/–
17,047,166	Stk. (£1)	British Oxygen Co. Ltd., Ord. ...	39/–	—3d.	10	10	5 2 6	40/–	29/–	39/–	29/6
600,000	Stk. (5/–)	Canning (W.) & Co.	23/–	+4½d.	25+ *2½C	25	5 8 9	23/–	19/7½	24/6	19/3
60,484	1/–	Carr (Chas.)	2/–	+1½d.	25	25	8 15 0X	2/3	1/4½	3/6	2/1½
150,000	2/–	Case (Alfred) & Co. Ltd.	4/6	+4½d.	25	25	11 2 3	4/9	4/–	4/6	4/–
555,000	1	Clifford (Chas.) Ltd.	19/9xd	+1½d.	10	10	10 2 6	20/–	16/–	20/6	15/9
45,000	1	Ditto Cum. Pref. 6%	15/6	—3d.	6	6	7 14 9	15/10½	15/7½	17/6	16/–
250,000	2/–	Coley Metals	3/3		20	25	12 6 3	4/6	2/6	5/7½	3/9
8,730,596	1	Cons. Zinc Corp.†	53/3	+6d.	18¾	22½	7 1 0	53/6	41/–	92/6	49/–
1,136,233	1	Davy & United	69/3	+1/–	20	15	5 15 6	72/6	45/9	60/6	42/6
2,750,000	5/–	Delta Metal	21/3	+3d.	30	*17½	7 1 3	22/4½	17/7½	28/6	19/–
4,160,000	Stk. (£1)	Enfield Rolling Mills Ltd.	35/–	+6d.	12½	15B	7 3 0	35/–	22/9	38/6	25/–
750,000	1	Evered & Co.	27/3		15Z	15	7 6 3	28/3	26/–	52/9	42/–
18,000,000	Stk. (£1)	General Electric Co.	37/9	+9d.	10	12½	5 6 0	38/7½	29/6	59/–	38/–
1,500,000	Stk. (10/–)	General Refractories Ltd.	37/6		20	17½	5 6 9	37/6	27/3	37/–	26/9
401,240	1	Gibbons (Dudley) Ltd.	62/6		15	15	4 16 0	66/3	61/–	71/–	53/–
750,000	5/–	Glacier Metal Co. Ltd.	7/3	+9d.	11¼	11¼	7 18 6	7/3	5/6	8/1½	5/10½
1,750,000	5/–	Glynwed Tubes	16/10½	—7½d.	20	20	5 18 6	17/6	12/10½	18/–	12/6
5,421,049	10/–	Goodlass Wall & Lead Industries ...	26/3	+9d.	13‖	18Z	4 19 0	25/9	19/3	37/3	28/9
342,195	1	Greenwood & Batley	50/6		20	17½	7 18 6	50/6	45/–	50/–	46/–
396,000	5/–	Harrison (B'ham) Ord.	14/1½		*15	*15	5 6 3	14/1½	11/6	16/9	12/4½
150,000	1	Ditto Cum. Pref. 7%	19/–		7	7	7 7 3	19/–	18/9	22/3	18/7½
1,075,167	5/–	Heenan Group	8/7½		10	20‡	5 16 0	8/7½	6/9	10/4½	6/9
216,531,615	Stk. (£1)	Imperial Chemical Industries ...	34/6	+6d.	12Z	10	4 12 9	34/6	27/7½	46/6	36/3
33,708,769	Stk. (£1)	Ditto Cum. Pref. 5%	17/–		5	5	5 17 9	17/1½	16/–	18/6	15/6
14,584,025	**	International Nickel	153	—¾	$3.75	$3.75	4 8 0	154¾	132¾	222	130
430,000	5/–	Jenks (E. P.), Ltd.	8/–	+3d.	27½ϕ	27½	8 11 9	8/3	6/9	18/10½	15/1½
300,000	1	Johnson, Matthey & Co. Cum. Pref. 5%	16/3xd	+3d.	5	5	6 3 0	16/9	15/–	17/–	14/6
3,987,435	1	Ditto Ord.	41/9	+6d.	10	10	4 15 9	45/3	36/6	58/9	40/–
600,000	10/–	Keith, Blackman	22/6		17½	15	7 15 6	22/6	15/–	21/9	15/–
160,000	4/–	London Aluminium	4/4½		10	10	9 2 9	4/4½	3/–	6/9	3/6
2,400,000	1	London Elec. Wire & Smith's Ord. ...	48/–	+9d.	12½	12½	5 4 3	48/–	39/9	54/6	41/–
400,000	1	Ditto Pref.	23/3		7½	7½	6 9 0	23/3	22/3	25/3	21/9
765,012	1	McKechnie Brothers Ord.	37/6		15	15	8 0 0	37/6	32/–	48/9	37/6
1,530,024	1	Ditto A Ord.	37/6	+1/6	15	15	8 0 0	37/6	30/–	47/6	36/–
1,108,268	5/–	Manganese Bronze & Brass	12/3		20	27½‡	8 3 3	12/3	8/9	21/10½	7/6
50,628	6/–	Ditto (7½% N.C. Pref.)	6/–	+3d.	7½	7½	7 10 0	6/3	5/9	6/6	5/–
13,098,855	Stk. (£1)	Metal Box	57/6	+6d.	11	11	3 16 6	57/6	41/9	59/–	40/3
415,760	Stk. (2/–)	Metal Traders	8/–	+3d.	50	50	12 10 0	8/1½	6/3	8/–	6/3
160,000	1	Mint (The) Birmingham	20/–		10	10	10 0 0	22/9	19/–	25/–	21/6
80,000	5	Ditto Pref. 6%	79/6		6	6	7 11 0	83/6	79/6	90/6	83/6
3,705,670	Stk. (£1)	Morgan Crucible A	40/6		10	10	4 18 9	40/6	34/–	54/–	35/–
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	17/6		5½	5½	6 5 9	17/6	17/–	19/3	16/–
2,200,000	Stk (£1)	Murex	49/9	+6d.	17½	20	7 0 9	58/9	47/9	79/9	57/–
468,000	5/–	Ratcliffs (Great Bridge)	10/6	+6d.	10	10	4 15 3	10/6	6/10½	8/–	6/10½
234,960	10/–	Sanderson Bros. & Newbould ...	24/9		20	27½D	8 1 6	27/–	24/6	41/–	24/9
1,365,000	Stk. (5/–)	Serck	15/4½	+1½d.	17½Z	15	3 16 0	15/4½	11/–	18/10½	11/6
600,400	Stk. (£1)	Stone (J.) & Co. (Holdings)	65/6		18	16	5 10 0	63/9	43/9	57/6	43/9
600,000	1	Ditto Cum. Pref. 6½%	23/6		6½	6½	5 10 9	24/3	19/6	21/9	18/9
14,494,862	Stk. (£1)	Tube Investments Ord.	61/6	+9d.	15	15	4 17 6	61/6	48/4½	70/9	50/6
41,000,000	Stk. (£1)	Vickers	33/10½	—1½d.	10	10	5 18 0	34/–	28/9	46/–	29/–
750,000	Stk. (£1)	Ditto Pref. 5%	15/–		5	5	6 13 3	15/6	14/3	18/–	14/–
6,863,807	Stk. (£1)	Ditto Pref. 5% tax free	21/9		*5	*5	7 1 3A	23/–	21/3	24/9	20/7½
2,200,000	1	Ward (Thos. W.), Ord.	83/6	+5/3	20	15	4 16 0	83/6	70/9	83/–	64/–
2,666,034	Stk. (£1)	Westinghouse Brake	40/3	+1/3	10	18P	4 19 6	40/3	32/6	85/–	29/1½
225,000	2/–	Wolverhampton Die-Casting ...	9/3	—3d.	25	40	5 8 0	9/6	7/1½	10/1½	7/–
591,000	5/–	Wolverhampton Metal	19/6		27½	27½	7 1 0	19/9	14/9	22/3	14/9
78,465	2/6	Wright, Bindley & Gell	4/4½	+4½d.	20	17½E	11 8 6	4/4½	3/3	3/9	2/7½
124,140	1	Ditto Cum. Pref. 6%	12/9	+1½d.	6	6	9 8 3	12/9	11/3	12/6	11/3
150,000	1/–	Zinc Alloy Rust Proof	2/10½		27	40D	9 7 9	3/1½	2/7½	5/–	2/9

*Dividend paid free of Income Tax. †Incorporating Zinc Corpn. & Imperial Smelting **Shares of no Par Value. ‡ and 100% Capitalized Issue. ●The figures given relate to the issue quoted in the third column. A Calculated on £7 14 6 gross. Y Calculated on 11¼% dividend. ‖ Adjusted to allow for capitalization issue. E for 15 months. P and 100% capitalized issue, also "rights" issue of 2 new shares at 35/– per share for £3 stock held. D and 50% capitalized issue. Z and 50% capitalized issue. B equivalent to 12½% on existing Ordinary Capital after 100% capitalized issue. ϕ And 100% capitalized issue. X Calculated on 17½%. C Paid out of Capital Profits.